

Hazard Profile – Flood

Summary

- The Hazard – Flooding, the overflow of water onto normally dry land (usually a river's floodplain) due to abnormal or excessive rainfall and associated runoff, is the most prevalent natural hazard facing Washington State residents.
- Previous Occurrences – Washington State has a long history of damaging floods, including the 1948 (Vanport) flood; the November, 1990 back-to-back floods (Veterans Day and Thanksgiving); and the February, 1996 event- the most widespread flooding in the State's history. These three floods are included in the National Weather Service's list of the Top Ten Washington State Weather Events in the 20th Century. Since 1956, Washington State has received 33 Presidential Disaster Declarations for flooding with each county in the State receiving at least one declaration during this period.
- Probability of Future Events – Based on historical records, recurrence intervals for damaging flood events in Washington State's most flood prone counties indicate major flooding will occur every three to five years.
- Jurisdictions at Greatest Risk – Western Washington is at the greatest risk for flooding, encompassing 12 counties within the Puget Sound Basin and along the Pacific Coast.

Introduction^{1, 2, 3}

Floods cause loss of life and damage to structures, crops, land, flood control structures, transportation infrastructure (roads and bridges) and utilities. Floods also cause erosion and landslides, and can transport debris and toxic products that cause secondary damage. Flood damage in Washington State exceeds damage by all other natural hazards.

There have been 33 Presidential Major Disaster Declarations for floods in Washington State from 1956 through January 2010. Every county has received a Presidential Disaster Declaration for flooding since 1970. While not every flood creates enough damage to merit a declaration, most are severe enough to warrant intervention by local, state or federal authorities.

Since 1980, federal, state and local governments have invested in excess of \$525 million to repair public facilities, help individuals recover from flood disasters, and pay for measures to prevent future flood damage. This is nearly 40 percent of the more than \$1.39 billion amount spent on disaster relief and hazard mitigation during this time.

The magnitude of most floods in Washington depend on the particular combinations of intensity and duration of rainfall, pre-existing soil conditions (e.g., was the ground wet or frozen before the storm), the size of the watershed, elevation of the rain or snow level, and amount of snow pack. Man-made changes to a basin also can affect the severity of floods.

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Although floods can happen at any time during the year, there are typical seasonal patterns for flooding in Washington State, based on the variety of natural processes that cause floods:

- Heavy rainfall on wet or frozen ground, before a snow pack has accumulated, typically cause fall and early winter floods.
- Rainfall combined with melting of the low-elevation snow pack typically cause winter and early spring floods. Of particular concern is the so-called Pineapple Express, a warm and wet flow of subtropical air originating near Hawaii which can produce multi-day storms with copious rain and very high freezing levels.
- Late spring floods in Eastern Washington result primarily from melting of the snow pack.
- Thunderstorms typically cause flash floods during the summer in Eastern Washington; on rare occasions, thunderstorms embedded in winter-like rainstorms cause flash floods in Western Washington.

Many rivers in Western Washington typically flood every two to five years; damaging flood events occur less frequently. These include rivers flowing off the west slopes of the Cascade Mountains (Cowlitz, Green, Cedar, Snoqualmie, Skykomish, Snohomish, Stillaguamish, Skagit, Nisqually, Puyallup, Lewis, and Nooksack); out of the Olympic Mountains (Satsop, Elwha, Dungeness, and Skokomish); and out of the hills of southwest Washington (Chehalis, Naselle, and Willapa). Long periods of rainfall and mild temperatures are normally the cause of flooding on these streams.

Several rivers in Eastern Washington also flood every two to five years, including the Spokane, Okanogan, Methow, Yakima, Walla Walla, and Klickitat; again, damaging events occur less frequently. Flooding on rivers east of the Cascades usually results from periods of heavy rainfall on wet or frozen ground, mild temperatures, or from the spring runoff of mountain snow pack.

Eastern Washington is prone to flash flooding. Thunderstorms, combined with steep ravines, alluvial fans, dry or frozen ground, and lightly vegetated ground that does not absorb water can result in flash flooding.

All of the Pacific coastal counties, Puget Sound and Strait of Juan de Fuca coastal counties, and counties at the mouth of the Columbia River, are susceptible to wind and barometric tidal flooding

Occasionally, communities experience surface water flooding due to high groundwater tables. This occurred dramatically during the 1996-97 winter storms. In many communities, residents outside of identified or mapped flood plains had several inches of water in basements due to groundwater seepage. These floods contaminated domestic water supplies, fouled septic systems, and inundated electrical and heating

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systems. Fire-fighting access was restricted, leaving homes vulnerable to fire. Lake levels were the highest in recent history, and virtually every county had areas of ponding not previously seen.

Urban areas across the state have also experienced urban or small stream flooding when a developed community's stormwater drainage system is overwhelmed by excessive rainfall and runoff from impervious surfaces such as roads and parking lots. While normally not life-threatening, such urban flooding can be very disruptive for residents. These events may increase as urban areas develop rapidly without commensurate improvements in urban drainage infrastructure.

Floodplains make up about 2.5 percent of the state's total land area. These areas contain an estimated 100,000 households. All the homes and people who live in them are vulnerable to flood damage. Only about 25 to 35 percent of the homes in floodplains have insurance for flood losses. Uninsured homeowners face greater financial liability than they realize. During a typical 30-year mortgage period, a home in a mapped floodplain has 26 percent chance of damage by a 100-year flood event. The same structure only has about a 1 percent chance of damage by fire.

Development in or near floodplains increases the likelihood of flood damage in two ways. First, new developments on or adjacent to a flood plain add structures and people in flood areas. Secondly, new construction alters surface water flows by diverting water to new courses or increases the amount of water that runs off impervious pavement and roof surfaces. This second effect diverts waters to places previously safe from flooding.

State Floodplain Management Program

The Washington State Department of Ecology (Ecology) Floodplain Management Program plays an important role in state mitigation with respect to flooding events. Program staff assists communities in administering their local floodplain management programs, make substantial damage determinations after a flood and ensure that communities are in compliance with their local ordinances. In addition, they work to provide assistance to non-participating communities that wish to enter the National Flood Insurance Program (NFIP) and provide technical assistance to participating communities interested in enrolling in the Community Rating System (CRS). Floodplain Management staff provides technical assistance to the Washington State Hazard Mitigation Advisory Team (SHMAT) as well as mitigation staff in administering the mitigation programs and developing a repetitive loss strategy for the state. Floodplain Management staff provides training to local government and emergency management officials on floodplain management and mitigation. Ecology also developed the Floodplain Management Guidebook, which provided additional planning guidance for local jurisdictions to meet FMA planning requirements with respect to NFIP, floodplain management and mitigation planning.

In addition to the above, Ecology supports ongoing updates to existing FEMA floodplain mapping and risk reduction programs. Ecology's Floodplain Management Program has

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partnered with FEMA under two FEMA programs - Map Modernization and Risk MAP - in support of effective implementation of floodplain regulations and flood hazard reduction. Both of these mapping programs are discussed in detail below.

National Flood Insurance Program (NFIP)⁴

The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968. NFIP allows property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is optional, and is based on an agreement between communities and the Federal Government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community as a financial protection against flood losses. This insurance is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods.

The emphasis of the NFIP floodplain management requirements is directed toward reducing threats to lives and the potential for damages to property in flood-prone areas. One key component in the Act is the restriction in place which prohibits FEMA from providing flood insurance to any individual unless the community within which the intended insured resides has adopted and enforces floodplain management regulations that meet or exceed the floodplain management criteria established within 44 Code of Federal Regulations (CFR) Part 60, *Criteria for Land Management and Use*.

As part of the NFIP, various funding opportunities are available for mitigation efforts. These funding opportunities are discussed in greater detail within the *Enhanced* portion of the SHMPH, Tab 7.

Two elements which must be met by all jurisdictions within the local mitigation plan is the issue of Repetitive Loss Properties and Severe Repetitive Loss properties as they relate to floods only. These are defined as:

➤ *Repetitive Loss Properties*

A repetitive loss property is one for which two or more losses of at least \$1,000 each have been paid by the National Flood Insurance Program (NFIP) over a rolling 10-year period.

➤ *Severe Repetitive Loss*

An SRL property is a residential property that is covered under an NFIP flood insurance policy and:

- a) That has at least four NFIP claim payments (including building and contents) over \$5,000 each, and the cumulative amount of such claims payments exceeds \$20,000; or

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- b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any 10-year period, and must be greater than 10 days apart.

In addition to providing flood insurance and reducing flood damages through floodplain management regulations, the NFIP identifies and maps the Nation's floodplains. Mapping flood hazards creates broad-based awareness of the flood hazards and provides the data needed for floodplain management programs and to actuarially rate new construction for flood insurance. Recently, this mapping initiative has taken a new step toward providing a more reliable mapping system with the creation of Risk MAP (discussed in greater detail below).

Community Rating System⁵

The National Flood Insurance Program's Community Rating System (CRS) was implemented in 1990 as a voluntary program which recognizes and encourages community floodplain management activities that exceed the minimum NFIP standards. The National Flood Insurance Reform Act of 1994 codified the Community Rating System in the NFIP.

As a result of CRS, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS:

- Reduce flood losses
- Facilitate accurate insurance rating
- Promote the awareness of flood insurance

The more a jurisdiction does in excess of NFIP standards, the more points they earn. These points are then utilized to establish the jurisdictions CRS class. There are ten CRS classes. Class one (1) requires the most credit points and gives the largest premium reduction; class 10 receives no premium reduction. For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount, and as indicated above, a Class 10 is not participating in the CRS and receives no discount.

The CRS classes for local communities are based on 18 creditable activities, organized under four categories:

1. Public Information
2. Mapping and Regulations
3. Flood Damage Reduction
4. Flood Preparedness.

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More information on the CRS program is available at on FEMA's website at:
<http://www.fema.gov/business/nfip/crs.shtm>

The table below describes the credit points earned, classification awarded and premium reductions given for Washington communities in the National Flood Insurance Program Community Rating System.

COMMUNITY NUMBER	COMMUNITY NAME	CRS ENTRY DATE	CURRENT CLASS	% DISCOUNT FOR SFHA
530073	Auburn, City of	10/1/92	5	25
530074	Bellevue, City of	10/1/92	5	25
530153	Burlington, City of	10/1/94	5	25
530103	Centralia, City of	10/1/94	5	25
530104	Chehalis, City of	10/1/94	5	25
530024	Clark County	10/1/04	5	25
530051	Ephrata, City of	10/1/00	7	15
530200	Everson, City of	10/1/94	7	15
530140	Fife, City of	05/1/06	5	25
530166	Index, Town of	04/1/98	6	20
530079	Issaquah, City of	10/1/92	5	25
530080	Kent, City of	05/1/10	6	20
530071	King County	10/1/91	2	40
530156	La Conner, Town of	10/1/96	8	10
530102	Lewis County	10/1/94	7	15
530316	Lower Elwha Klallam Tribe	10/1/00	7	15
530331	Lummi Nation	05/1/10	8	10
530169	Monroe, City of	10/1/91	5	25
530158	Mount Vernon, City of	05/1/97	7	15
530085	North Bend, City of	10/1/95	6	20
530143	Orting, City of	05/1/08	6	20
530138	Pierce County	10/1/95	3	35
530088	Renton, City of	10/1/94	6	20
530151	Skagit County	04/1/98	4	30
535534	Snohomish County	05/1/06	5	25
530090	Snoqualmie, City of	10/1/92	5	25
530173	Sultan, City of	10/1/03	7	15
530204	Sumas, City of	10/1/93	7	15
530188	Thurston County	10/1/00	5	25
530193	Wahkiakum County	10/1/07	8	10
530067	Westport, City of	10/1/09	6	20
530198	Whatcom County	10/1/96	6	20
530217	Yakima County	10/1/07	8	10

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Map Modernization Program⁶

The objective to FEMA's Map Modernization Program is to update and modernize maps that predict where major floods are likely to occur. Map Modernization is a cornerstone for helping States and communities to be better prepared for flood disasters. However, presently, not all of Washington State's high hazard areas are being updated. At present, Countywide Digital Flood Hazard Data is available, or in process, for the following Washington Counties:

Adams	Lewis
Clallam	Pierce
Clark	Skagit
Cowlitz	Snohomish
Grant	Spokane
Grays Harbor	Thurston
King	Whatcom
Kitsap	Yakima

Risk MAP (Risk Mapping Assessment and Planning)⁷

The purpose behind FEMA's Risk MAP Strategy is to constantly reduce losses to life and property. Flood mapping is used for risk assessments which are incorporated into mitigation plans where risk reduction measures are identified for future action. Risk MAP will identify, assess, and communicate multi-hazard risks with non-regulatory products and assessments. Washington State Department of Ecology is partnering with FEMA to implement the four fundamental strategies to Risk MAP in Washington State. The four strategies include Identify Risk, Assess Risk, Communicate Risk, and Mitigate Risk. The Risk MAP program further enhances mapping by involving communities during the assessment and planning stages, and guides and encourages communities to communicate risk to their constituents.

The information in the following sections provides statistical data as it relates to Washington's involvement in the NFIP during the 2010 plan update process. Information is always changing, and therefore, as local jurisdiction plans are updated, the most current data should be gathered to meet planning requirements from the Emergency Management Division, Department of Ecology, or FEMA. At present time, the facts below demonstrate the overall importance of the NFIP to the State and demonstrate the level of flooding concern. The information represents the most currently available data as of the dates referenced within each section.

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History of Occurrence:

Significant Floods in Washington State – 1948 to 2009

The following is a synopsis of damaging floods that occurred in this half-century. It is not a complete history of flood events, but a sample for which documentation is readily available that shows the breadth of the flood problem in Washington.

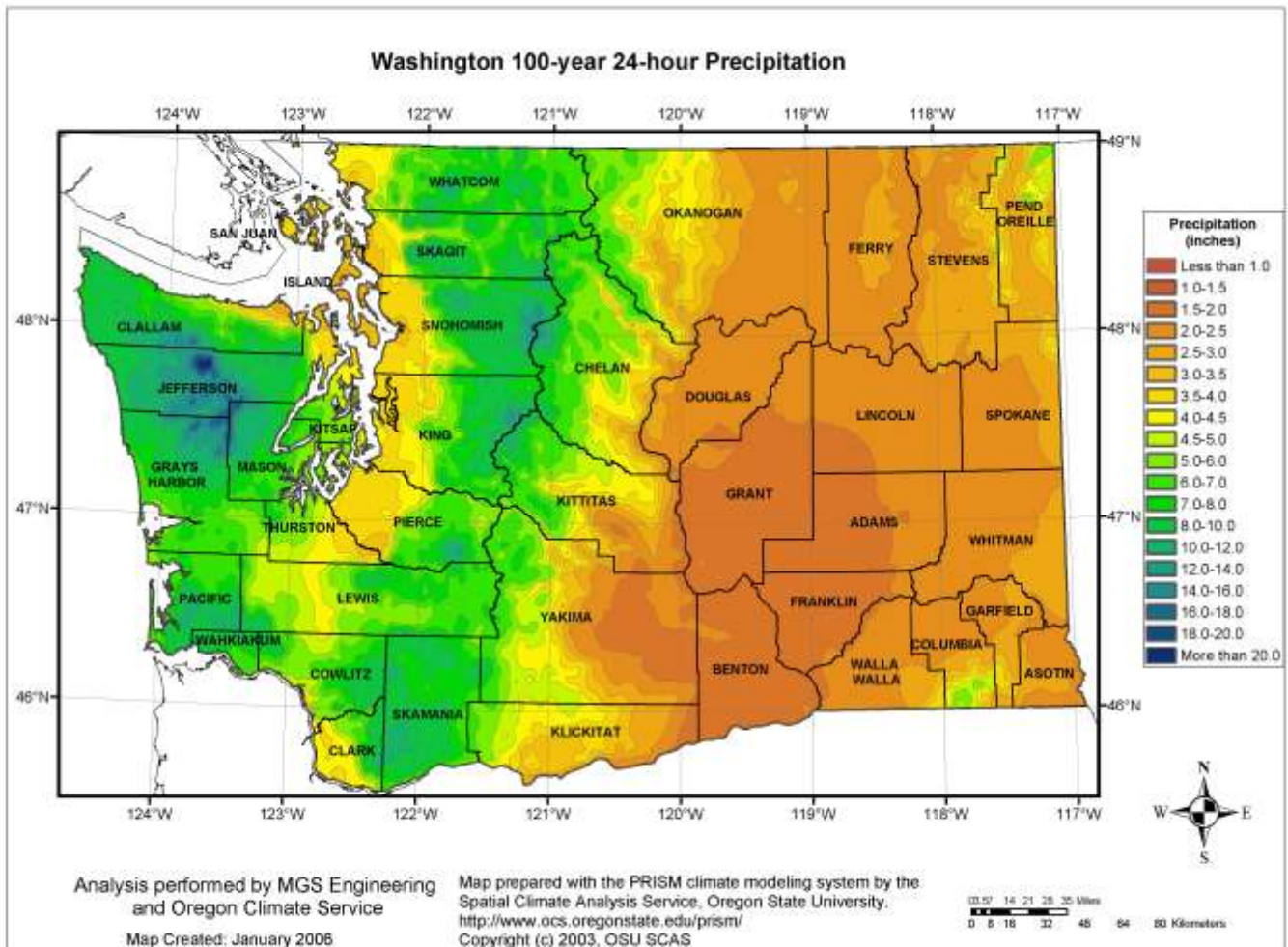
Several flood disasters described below include narratives or tables that depict projected recurrence rates for floods of the magnitude observed; information is for events and selected rivers, streams and lakes for which data is available. The probability of a flood event occurring is expressed as a percent chance that a flood of a specific magnitude will occur in any given year. For example, a flood with a 10-year recurrence rate has a 10 percent chance of occurring in any one year.

The table below demonstrates how recurrence rate translates to the chance of occurrence for the types of floods the state has experienced.

Flood Return Intervals	Chance of Occurrence In Any Given Year
10 Years	10%
20 Years	5%
25 Years	4%
50 Years	2%
100 Years	1%
500 Years	0.2%

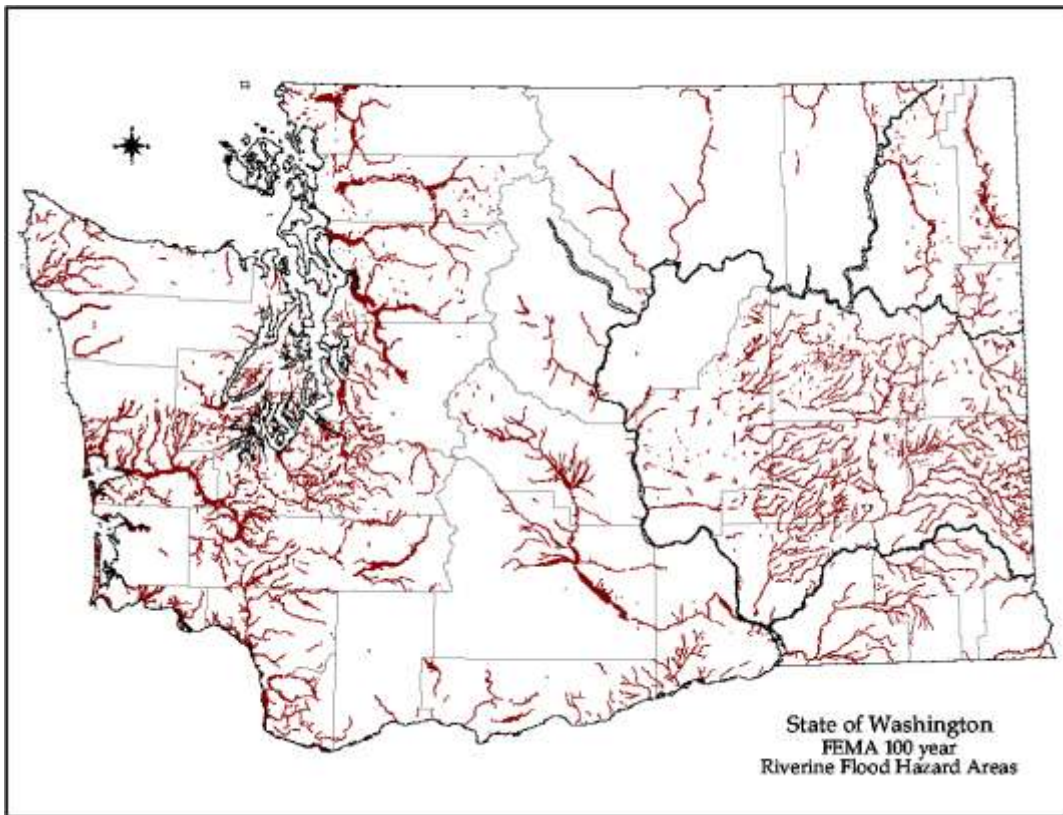
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Map of 24-hour precipitation totals that would qualify as a 100 year event (from MGS Engineering Consultants).⁸



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For some tables below, recurrence intervals determined using data in *Magnitude and Frequency of Floods in Washington*, Department of Interior, United States Geological Survey Water-Resources Investigations Report 97-4277, 1998.



Source: Department of Ecology, Floodplain Management Program

*May-June 1948*⁹

Vanport Flood. (One of the top 10 weather events in Washington during the 20th Century, according to National Weather Service, Seattle Forecast Office).

Snowmelt flooding broke lake and river records in Eastern Washington and along the Columbia River to the Pacific Ocean. The Columbia River below Priest Rapids, WA, established a new flood of record at 458.65 feet (flood stage 432.0 feet). The Methow River at Pateros, WA, established a new flood of record at 12.30 feet (flood stage 10.0 feet). The flood lasted 45 days.

Vancouver, Camas, Kalama, and Longview suffered flood damage. This flood is most notable for wiping out the community of Vanport in North Portland in less than one hour as dikes along the Columbia River gave way. Vanport, America's largest wartime housing project was not rebuilt.

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Recurrence interval of this Columbia River flood is projected at 30 years.¹⁰ A number of hydroelectric dams constructed on the Columbia after this event also control flooding, reducing the probability of flooding along much of the length of the river in Washington.

January 1971

Federal Disaster #300.

Snow melt in the counties of Columbia, Garfield, Grays Harbor, Lewis, Skagit, Whatcom and Yakima, combined with heavy rains, produced major flooding throughout the region.

January 1972

Federal Disaster #322.

Severe storms in the counties of Asotin, Cowlitz, Grays Harbor, Lewis, Pacific, Skamania, Thurston, Wahkiakum and Whitman counties caused flooding throughout the region.

February 1972

Federal Disaster #328.

Heavy rains in the counties of King, Pierce and Thurston produced major flooding throughout the area.

May-June 1972

Federal Disaster #334.

Snow melt in north-central Washington counties of Chelan, Douglas, and Okanogan, combined with heavy rains, produced major flooding on the Okanogan and Methow Rivers in Okanogan County and the Entiat River in Chelan County. All three rivers reached record flood stages.

Recurrence intervals for flood levels are not available for this disaster.

January 1974

Federal Disaster #414.

Unseasonably warm temperatures (+/- 65 degrees) , along with monsoon-like rains caused extensive flooding within three states: Washinton, Oregon and Idaho. The counties of Asotin, Benton, Columbia, Ferry, Kitsap, Klickitat, Lewis, Mason, Pend Oreille, Stevens, Thurston, Whitman, and Yakima were declared within the state of Washington.

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December 1975

Federal Disaster #492.

Unusually heavy and warm rains, together with warm, strong winds, caused flooding mainly within western Washington – Cowlitz, Grays Harbor, King, Lewis, Mason, Pierce, Skagit, Snohomish, Whatcom and Thurston Counties, but also impacted a number of eastern Washington counties: Benton, Kittitas and Yakima. This disaster was considered a statewide event. On the Snohomish River, though the discharge at Monroe was only the fifth largest (the November 25 1990 flood discharge being the largest on record), the 1975 flood produced the highest flood stage ever recorded on the Snohomish at the City of Snohomish; this stage was 34 feet, which is higher than both the January 2009 and November 2006 floods. Snohomish River flooding in the 1975 flood was (in)famous for the drowning of over 2,000 head of cattle, which spurred the concept of establishing “critter pads” in many western Washington floodplains.

According to estimates of the Federal Disaster Assistance Administration of HUD (FEMA not being created until 1979), there was \$35 million in losses during this flood. These losses were estimated to include \$17 million in public losses, \$13 million in agricultural losses and \$5 million in private property losses (later estimates ranged up to \$70 million in damages).

December 1977¹¹

Federal Disaster #545.

Severe storms, mudslides, high tides and flooding categorized this event as a very large Statewide flood that included a record 16 counties, both in western (10 counties) and eastern (6 counties) Washington. Impacted were: Benton, Clark, Cowlitz, Garfield, Grays Harbor, King, Kittitas, Klickitat, Lewis, Pacific, Pierce, Snohomish, Thurston, Wahkiakum, Whitman and Yakima Counties.

This event closed both I-90 and I-5 due to slides and high water on the road surface, trapped two freight trains due to washout of the tracks, caused four deaths and left thousands homeless. Every major western Washington river experienced some flooding, and there was serious flooding on the Naches and Yakima Rivers in eastern Washington.

Estimates indicated damages to be in the tens of millions of dollars. According to a December 4, 1977 news article in the Seattle Times, Senator Henry Jackson was quoted as saying “this year’s flood is clearly more severe than the floods of 1975, which caused \$70 million in damage”. Attached, mainly for your records, are some news articles that give an indication of the seriousness of the event.

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December 1979

Federal Disaster #612

Storms, high tides, mudslides and flooding impacted the counties of Clallam, Grays Harbor, Jefferson, King, Mason, Skagit, Snohomish and Whatcom. This event produced a record rainfall of 12.7 inches; normal rainfall for the same time of year at SeaTac was 5.94 inches. The flood event started on December 15th, with most rivers peaking between December 17-20, 1979.

Although most of the damages were on streams that flowed out of the Cascades, flooding on these streams were mostly 5-10 year floods. Flooding was much more severe on the Olympic Peninsula, though damages were less severe because there were no large populations along these rivers. The Bogachiel, Calawah and Hoh Rivers were 50-year floods or greater. Total damage figures for this event was approximately \$8 million, and the declaration was only for individual assistance only.

*December 1982*¹²

Federal Disaster #676

Disaster assistance provided – \$1.7 million. Small Business Administration loaned \$1 million to home and business owners for damages.

Flooding, severe storm, and high tide affected Whatcom County. Four persons injured, 122 people evacuated; 129 homes and 113 businesses damaged; \$1.7 million in public facility damage.

Recurrence intervals for flood levels are not available for this disaster.

*January 1986*¹³

Federal Disaster #757

Flooding and severe storms in Clallam, Jefferson, and King Counties caused \$5 million in damage to public facilities.

Recurrence intervals for flood levels are not available for this disaster.

*February 1986*¹⁴

Federal Disaster #762

Flooding, heavy rainfall, and mudslides in Cowlitz County caused \$5 million in damage to public facilities and private property.

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Recurrence interval of the Cowlitz River flood at Castle Rock projected at 2 years.

*November 1986*¹⁵

Federal Disaster #784

Disaster assistance provided – \$1.9 million.

Heavy rainfall, mild temperatures, and low-elevation snowmelt generated major floods on the Chehalis, Skookumchuck, Skykomish, Snoqualmie, and Snohomish Rivers. Less severe flooding occurred on the Satsop, Skokomish, Cedar, Stillaguamish, Skagit, and Nooksack Rivers. Flooding occurred in Cowlitz, King, Lewis, Pacific, Snohomish, and Wahkiakum Counties.

Two deaths, \$11 million in private property damage, and \$6 million in public facility damage.

One-hundred twenty homes in the City of Snoqualmie were evacuated. Two-hundred eighty homes and businesses were flooded in Lewis County; impacts included a major hazardous materials spill (pentachlorophenol) from an underground storage tank and Lewis County was fairgrounds under nine feet of water.

Numerous levees overtopped and damaged throughout flooded counties.

Disaster #784, Flood Recurrence Interval This Event, Selected Rivers

River (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Snoqualmie (King County)	15 – 20 Years	4 – 6%
Skykomish (Snohomish County)	10 – 25 Years	4 – 10%
Snohomish (Snohomish County)	5 – 15 Years	6 – 20%
Puyallup (Pierce County)	40 – 45 Years	~2%
Chehalis (Grays Harbor County)	45 – 50 Years	~2%

*March 1989*¹⁶

Federal Disaster #822. Stafford Act disaster assistance provided – \$3.8 million.

Flooding and heavy rainfall affected Douglas, Okanogan, Stevens, and Whitman Counties. Roads and utilities heavily damaged in four rural counties. Mud from flooding impaired the city of Bridgeport's sewage treatment facility for months. Total damage to public facilities was \$2 million.

Recurrence intervals for flood levels are not available for this disaster.

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*January 1990*¹⁷

Federal Disaster #852. Stafford Act disaster assistance provided – \$17.8 million.

Flooding occurred on the Chehalis, Skookumchuck, and Deschutes Rivers as heavy rainfall and severe storms affected Benton, Grays Harbor, King, Lewis, Pierce, Thurston, and Wahkiakum Counties.

Four deaths; \$16 million in damages to public facilities and \$6 million private property damage.

Hundreds of people evacuated, several hundred homes and businesses damaged or destroyed. Chehalis hospital isolated by floodwaters; several nursing homes evacuated. Interstate 5 in Chehalis closed for several days, covered by 3 to 5 feet of water.

Recurrence intervals for flood levels are not available for this disaster.

November 1990^{18, 19}

Federal Disaster #883. Stafford Act disaster assistance provided – \$57 million.

One of the top 10 weather events in Washington during the 20th Century, according to National Weather Service, Seattle Forecast Office.

Severe storms and flooding occurred during Veteran's Day and Thanksgiving weekend holidays in Chelan, Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, Wahkiakum, Whatcom, and Yakima counties.

Widespread, major flooding occurred in both Western and Eastern Washington. Rivers with major flooding were the Skagit and Nooksack Rivers. The Thanksgiving weekend floods set record flood stages on the Naselle, Willapa, Hoh, Calawah, Dungeness, Skokomish, Cedar, Skykomish, Snoqualmie, Snohomish, Stillaguamish, Chiwawa, Wenatchee, Elwha, and Klickitat Rivers.

Two people died; more than 500 cattle perished. Damage estimated at \$250 million.

Many levees overtopped and damaged. Hundreds of homes evacuated; much of the city of Snoqualmie evacuated.

Thousands of acres of farmland flooded and evacuated; on Fir Island, Skagit County, 167 homes were flooded by 8 feet of water; on Eby Island, Snohomish County, only people with elevated homes stayed.

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Disaster #883, Flood Recurrence Interval This Event, Selected Rivers

River (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Skagit (Skagit County)	50 Years	2%
Snohomish (Snohomish County)	50 – 100 Years	1 – 2%
Nooksack (Whatcom County)	100 Years	1%

December 1990

Federal Disaster #896. Stafford Act disaster assistance provided – \$5.1 million.

Floods, storms, and high winds affected the counties of Island, Jefferson, King, Kitsap, Lewis, Pierce, San Juan, Skagit, Snohomish, and Whatcom.

Recurrence intervals for flood levels are not available for this disaster.

November – December 1995²⁰

Federal Disaster #1079. Stafford Act disaster assistance provided – \$45.9 million. Small Business Administration disaster loans approved - \$4.3 million.

Flooding and wind in the counties of Chelan, Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kittitas, Lewis, Mason, Pacific, Pierce, Skagit, Snohomish, Thurston, Wahkiakum, Whatcom, and Yakima.

More than 850 homes damaged or destroyed; one death reported.

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Disaster #1079, Flood Recurrence Interval This Event, Selected Rivers²¹

River (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Naselle near Naselle (Pacific County)	10 Years	10%
Quinault at Quinault Lake (Grays Harbor County)	10 Years	10%
American River near Nile (Yakima County)	10 Years	10%
Snoqualmie, multiple locations (King County)	10 – 25 Years	4 – 10%
Willapa near Willapa (Pacific County)	15 Years	7%
Snohomish (Snohomish County)	20 Years	5%
Cedar, multiple locations (King County)	20 – 40 Years	~2 – 5%
Nooksack near Ferndale (Whatcom County)	25 Years	4%
Sauk near Sauk (Skagit County)	25 Years	4%
Skagit, multiple locations (Skagit County)	50 – 75 Years	~2%
Cowlitz, multiple locations (Cowlitz County)	50 – 100 Years	1 – 2%
Nisqually at LaGrande (Thurston County)	50 Years	2%
Puyallup at Alderton (Pierce County)	100 Years	1%
Stehekin at Stehekin (Chelan County)	100 Years	1%
Wenatchee, multiple locations (Chelan County)	100 Years	1%

February 1996^{22, 23}

Federal Disaster #1100. Stafford Act disaster assistance provided – \$113 million.
Small Business Administration disaster loans approved - \$61.2 million.

One of the top 10 weather events in Washington during the 20th Century, according to National Weather Service, Seattle Forecast Office.

Heavy rainfall, mild temperatures and low-elevation snowmelt caused flooding in Adams, Asotin, Benton, Clark, Columbia, Cowlitz, Garfield, Grays Harbor, King, Kitsap, Kittitas, Klickitat, Lewis, Lincoln, Pierce, Skagit, Skamania, Snohomish, Spokane, Thurston, Wahkiakum, Walla Walla, Whitman and Yakima counties, and the Yakima Indian Reservation.

Record floods occurred on the Columbia, Snoqualmie, Cedar, Chehalis, Nisqually, Skookumchuck, Klickitat, Skokomish, Cowlitz, Yakima, Naches, Palouse and Walla Walla Rivers, and Latah Creek. The table below shows how frequently flooding of the magnitude observed in this event will occur on selected rivers and streams for which data is available.

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Disaster #1100, Flood Recurrence Interval This Event, Selected Rivers and Streams²⁴

River / Stream (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Ahtanum Creek (Yakima County)	20 Years	5%
Deschutes River (Thurston County)	25 Years	4%
South Prairie Creek (Pierce County)	37 Years	3%
Newaukum River (Lewis County)	90 Years	~1%
Chehalis River (Thurston, Lewis Counties)	90 – 100 Years	1%
Newaukum Creek (King County)	100 Years	1%
Puyallup River (Pierce County)	100 Years	1%

Mudslides occurred throughout the state causing significant impacts to transportation infrastructure including highways and rail corridors.

Three deaths, 10 people injured. Nearly 8,000 homes damaged or destroyed. Traffic shut down for several days both east and west, and north and south, along major state highways. Snow avalanches closed Interstate 90 at Snoqualmie Pass. Mudslides in Cowlitz County and flooding in Lewis County closed Interstate 5. Damage throughout the Pacific Northwest estimated at \$800 million.

December 1996 - January 1997²⁵

Federal Disaster #1159. Stafford Act disaster assistance provided – \$83 million. Small Business Administration loans approved – \$31.7 million.

Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day period to cause flooding.

Impacted counties – Adams, Asotin, Benton, Chelan, Clallam, Clark, Columbia, Cowlitz, Douglas, Ferry, Franklin, Garfield, Grant, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Klickitat, Lewis, Lincoln, Mason, Okanogan, Pacific, Pend Oreille, Pierce, San Juan, Skagit, Skamania, Snohomish, Spokane, Stevens, Thurston, Walla Walla, Whatcom, Whitman, and Yakima.

Significant urban flooding occurred north of Pierce County; significant river flooding occurred south of Pierce County; severe groundwater flooding took place in Pierce and Thurston Counties. The table below shows how frequently flooding of the magnitude observed in this event will occur on selected rivers and lakes for which data is available.

Hazard Profile – Flood

Disaster #1159, Flood Recurrence Interval, Selected Rivers and Lakes²⁶

River / Lake (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Chehalis River (Grays Harbor County)	10 Years	10%
Klickitat River (Klickitat County)	10 Years	10%
Palouse River (Whitman County)	10 Years	10%
Skookumchuck River (Lewis County)	10 Years	10%
White Salmon River (Skamania County)	10 Years	10%
Black Lake (Thurston County)	40 Years (lake elevation)	~2%
Scott Lake (Thurston County)	40 Years (lake elevation)	~2%
Deschutes River (Thurston County)	45 Years	~2%
Lake Sammamish (King County)	70 Years (lake elevation)	~1.5%
Newaukum River (Lewis County)	100 Years	1%

Twenty-four deaths; \$140 million (est.) in insured losses; 250,000 people lost power.

More than 130 landslides occurred between Seattle and Everett, primarily along shorelines. Interstate 90 at Snoqualmie pass closed due to avalanche.

March 1997

Federal Disaster #1172. Stafford Act disaster assistance provided – \$6.5 million. Small Business Administration disaster loans approved – \$2.9 million

Heavy rainfall and low-elevation mountain snowmelt caused flooding in counties of Grays Harbor, Jefferson, King, Kitsap, Lincoln, Mason, Pacific, Pierce, Pend Oreille, and Stevens. The table below shows how frequently flooding of the magnitude observed in this event will occur on selected rivers for which data is available.

Disaster #1172, Projected Flood Recurrence Interval This Event, Selected Rivers

River (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Naselle River (Pacific County)	100 Years	1%
Satsop River (Grays Harbor County)	200 Years	0.5%
Wynoochee River (Grays Harbor County)	200 Years	0.5%

Hazard Profile – Flood

May 1998

Federal Disaster #1252. Stafford Act disaster assistance provided – \$3.6 million. Heavy rainfall caused flooding in Ferry and Stevens Counties. Recurrence intervals for flood levels are not available for this disaster.

October 2003²⁷

Federal Disaster #1499. Stafford Act disaster assistance provided to date –\$5.8 million. Small Business Administration disaster loans approved – \$2.1 million.

Heavy rainfall caused severe flooding in Chelan, Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Okanogan, Pierce, San Juan, Skagit, Snohomish, Thurston and Whatcom counties. Most severe flooding took place along the Skagit River. Record flood levels were set on the Skagit River at Concrete, Sauk River, and Stehekin River.

More than 3,400 people were evacuated. Thirty-three homes were destroyed, 112 homes had major damage, with property damage estimated at \$30 million. Numerous federal, state and county roads were damaged by landslides and floodwaters.

Disaster #1499, Projected Flood Recurrence Interval This Event, Selected Rivers

River (County)	Flood Recurrence Interval	Chance of Annual Occurrence
Nooksack at Deming (Whatcom County)	25 Years	4%
Skagit near Mount Vernon (Skagit County)	40 Years	~2%
Sauk near Sauk (Skagit County)	100 Years	1%
Stillaguamish at Arlington (Snohomish County)	100 Years	1%
Skokomish near Potlatch (Mason County)	100 – 200 Years	0.5 – 1%
Stehekin at Stehekin (Chelan County)	100 – 200 Years	0.5 – 1%

January 2006

Federal Disaster # 1641. Declared by Governor Gregoire on 12 January 2006, this event was the climax of a month of steady rainfall beginning in mid-December. Initially involving counties in the Puget Sound Basin and Spokane, the declaration eventually was extended to all 39 counties. Flooding, landslides and mudflows seriously impacted state and local transportation infrastructure across the state as well as damaging homes and businesses.

Hazard Profile – Flood

November 2006

Federal Disaster #1671. A powerful series of moist subtropical rainstorms battered much of the state from 2-11 November 2006. The Governor proclaimed an initial emergency on 6 November and on 9 November expanded her Proclamation to cover 24 of the state's 39 counties. A number of streams reached record flood levels including the Cowlitz River at Randle; the Snoqualmie River at Carnation; and the Carbon River near Fairfax.

Mt. Rainier National Park was severely impacted with damage totals exceeding \$30 million to park infrastructure. During the period from November 2 to 7, 24.1 inches of rain fell at the Paradise visitor center, resulting in unprecedented destruction to roads, bridges, campgrounds, trails and other Park facilities. This storm was one of Washington's worst, making it onto the list of *Washington 2006 Top 10 Weather and Climate Events*.²⁸ A total of 2,388 people applied to FEMA for assistance. Stafford Act funds provided in excess of \$38 million in assistance.

Washington November 2006 Precipitation Totals²⁹

City	Nov. 2006	Nov. Normal	Nov. Record	Monthly Record	Graphs & Data
Bellingham	8.10"	5.44"	11.60" (1990)	11.60" (11/1990)	1 Data
Chelan/Lakeside **	2.94"	1.61"	6.20" (1983)	6.20" (11/1983)	1 Data
Forks **	29.28"	17.72"	32.52" (1983)	41.70" (01/1953)	1 Data
Hoquiam *	21.38"	10.30"	18.03 (1990)	19.64" (12/1996)	1 Data
Olympia	19.68"	8.13"	15.51" (1962)	19.84" (01/1953)	1 Data
Quillayute *	30.76"	14.82"	29.14" (1983)	29.14" (11/1983)	1 2 Data
Quinalt	51.91"	N/A	N/A	N/A	1 Data
Seattle	15.63"	5.90"	11.62" (1998)	12.92 (01/1953)	1 2 Data
Spokane	4.38"	2.24"	5.85" (1897)	5.85" (11/1897)	1 2 Data
Stampede Pass *	28.03"	12.84"	25.43" (1958)	29.06" (12/1953)	1 Data
Yakima	1.14"	1.05"	2.83" (1973)	5.59" (12/1996)	1 2 Data
Vancouver	13.31"	6.29"	12.92" (1942)	15.04" (12/1933)	1 Data

Denotes new record November rain total
* Includes estimated totals for missing data

Denotes new record monthly rain total
** Missing Data

Hazard Profile – Flood

December 2006

Federal Disaster #1682. A series of severe winter storms during the time period 14-15 December 2006 caused flooding, landslides and mudslides for 19 Washington counties. High winds reached speeds of 113 mph in the cascades. Saturated soils brought down trees and power lines. A total of 15 fatalities were reported; one woman became trapped in her basement as water rushed into the room and jammed the door shut, 8 were due to carbon monoxide poisoning from generators. The President issued a major disaster declaration as a result of those storms. Under this declaration, the Public Assistance (PA) program of the Federal Emergency Management Agency (FEMA) was made available to entities in Chelan, Clallam, Clark, Grant, Grays Harbor, Island, King, Klickitat, Lewis, Mason, Pacific, Pend Oreille, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston and Wahkiakum counties. Stafford Act funds provided in excess of \$37 million in assistance. Recurrence intervals for flood levels are not available for this disaster. Additional information on this disaster is available at: <http://www.fema.gov/news/event.fema?published=1&id=7565>

December 2007³⁰

Federal Disaster #1734. During the time period December 1-3, 2007, three storms moved over the Pacific Northwest. December 1st marked the first in the series, producing heavy snow in the mountains and low-land snow throughout western Washington. Snow fall levels ranged from a trace to 1" in Seattle, to many areas away from Puget Sound receiving over 4". On December 2nd, the snow changed over to rain as temperatures increased, accompanied by strong winds. As a low pressure system moved over the Olympic Peninsula, wind gusts of over 80 mph were observed along much of the coast (Hoquiam 81, Destruction Island 93, Tatoosh Island 86) and 40 to 50+ mph inland (Olympia 44, Seattle 48, Bellingham 53).

The most significant of the three storms arrived December 3rd, with near record high temperatures (59°F for Seattle) and moist tropical air which led to record rainfall and flooding around western Washington. Reports indicate that 6-hour and 24-hour precipitation amounts were at or near 100-year rain frequency levels. For Sea-Tac Airport, December 3, 2007 became the 2nd wettest day on record with 3.77" (first is 4.93" recorded on October 20, 2003) and the wettest day on record for Bremerton which received 7.50" of rain, breaking the old record of 5.62" set December 10, 1921.

Several sites reached all time record high river flows and set all-time record high flood stage levels, including the Chehalis, which reached nearly 75 ft (10 feet over flood stage), breaking the previous record set in the floods of February 1996. The flooding of the Chehalis River led to widespread flooding throughout western Lewis County, including a stretch of I-5, forcing 20 miles of the interstate to be closed for 4 days. The Coast Guard rescued more than 300 people from the flood areas, and the flooding and mudslides resulted in at least 5 deaths.

Hazard Profile – Flood

A major disaster declaration was issued for 10 counties for Individual Assistance and 12 counties for Public Assistance, comprised of Clallam, Grays Harbor, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Skagit, Snohomish, Thurston and Wahkiakum counties.

Individuals Assistance (IA), SBA low-interest disaster loans and Public Assistance programs were made available to those jurisdictions impacted

As of March 2008, the breakdown of losses were as follows: ³¹

County	HA	ONA	SBA	PA
Clallam	\$219,359	\$11,623	\$251,400	\$277,978
Grays Harbor	\$1,556,046	\$234,918	\$3,867,600	\$2,326,407
Jefferson	N/A	N/A	N/A	\$201,216
King	\$1,370,211	\$160,353	\$1,594,700	\$1,845,386
Kitsap	\$1,401,024	\$59,419	\$1,255,500	\$1,195,046
Lewis	\$9,583,635	\$2,266,483	\$19,615,500	\$8,034,990
Mason	\$1,202,781	\$58,506	\$1,984,700	\$1,997,304
Pacific	\$475,217	\$49,697	\$1,340,100	\$231,576
Skagit	N/A	N/A	N/A	\$21,050
Snohomish	\$494,205	\$37,233	\$724,700	\$1,398,783
Thurston	\$726,581	\$4,180	\$823,400	\$1,117,943
Wahkiakum	\$128,659	\$28,531	\$85,800	\$160,561
Statewide (PA)	N/A	N/A	N/A	\$2,104,756
TOTAL	\$17,157,718	\$2,910,943	\$31,543,400	\$20,912,996

Legend: **HA** = Housing Assistance; **ONA** = Other Needs Assistance; **SBA** = Small Business Administration Disaster loans; **PA** = Public Assistance for state and local governments, tribes and non-profits (the 75% federal share of completed Project Worksheets); **N/A** = These counties were not designated for Individual Assistance. Additional information on this event is available at: <http://www.fema.gov/news/event.fema?published=1&id=9126> and <http://www.climate.washington.edu/events/dec2007floods/>

January 2009

*Federal Disaster No 1817*³². A strong, warm and very wet Pacific weather system brought copious amounts of rainfall to Washington during the period 6-8 January, 2009, with subsequent major flooding extending through January 11, 2009, as well as minor flooding that continued through most of January. The storm involved a strong westerly flow aloft with embedded sub-tropical moisture, known as an *atmospheric river* of moisture. Snow levels rose from low levels to between 6,000 and 8,000 feet, with strong westerly winds enhancing precipitation amounts in the mountains. Antecedent conditions from a mid-December through early January region-wide cold snap and associated heavy snow helped set the stage for the flooding. This event also produced avalanches in the mountains, and caused more than an estimated 1,500 land/mudslides across the state, and resulted in structural damage to buildings from added snow load, compounded by heavy rains.

Hazard Profile – Flood

All counties of Western Washington lowlands received 3-8 inches of rain, while east of the Cascades, amounts ranged from 2 to 7.5 inches. On January 7, 2009, Olympia set a daily record with 4.82 inches. The National Weather Service issued flood warnings for 49 flood warning points across the state. Some daily rainfall records were broken (but not all-time) on January 7th at airports: Sea-Tac saw 2.29 inches that broke 1.33 inches on January 7th in 1996, Olympia saw 4.82 inches breaking 1.95 set on January 7, 2002, and Quillayute saw 2.88 inches breaking 2.39 set on January 7, 1983 (from NWS).

Emergency Alert System was activated by NWS Seattle and Portland as 22 Western Washington rivers exceeded *major* flood category. Two rivers, the Naselle in Pacific County and the Snoqualmie reached all-time record crests. Six rivers had near-record crests, while Mud Mountain Dam and How Hanson Dam had record levels of inflows. The State's primary north-south rail line was also closed and ice jam flooding was also a problem. Interstate-5 was closed from milepost 68 to 89 for 43 hours due to water over the roadway around Chehalis. The economic impact of this closure is estimated at \$12 million per day.

Public Assistance was provided to 22 counties, while Individual Assistance was provided to 15 counties. As of March 2009, approximately \$10 million in federal disaster assistance was paid to Washington residents, with 3,465 homeowners and renters applying for disaster assistance.

Jurisdictions Most Vulnerable to Flooding

For the State Hazard Mitigation Plan, factors used to determine which counties are most vulnerable to future flooding are:

- Frequency of flooding that causes major damage, based on the number of Presidential Disaster Declarations in the past half century as an indicator (recurring every seven years or less) – a measure of how often serious, damaging flood events occur.
- Percentage of the County in Floodplain (land area only minus water bodies) (2 percent or more of the area of the county) – a measure of the size of the area within a county at-risk to flooding.
- Number of Flood Insurance Policies Currently in Effect (top 19 counties) – a measure of the built environment in the floodplain.
- Number of Flood Insurance Claims Paid Since 1978 (top 24 counties) – another measure of the built environment in the floodplain.
- Number of Repetitive Flood Loss Properties (measured by county) – a measure of how often serious, damaging flood events occur.

Hazard Profile – Flood

- Number of Severe Repetitive Loss Properties (measured by county) – a measure of how often serious, damaging flood events occur.

Based on these factors, the following counties are at greatest risk and most vulnerable to flooding:

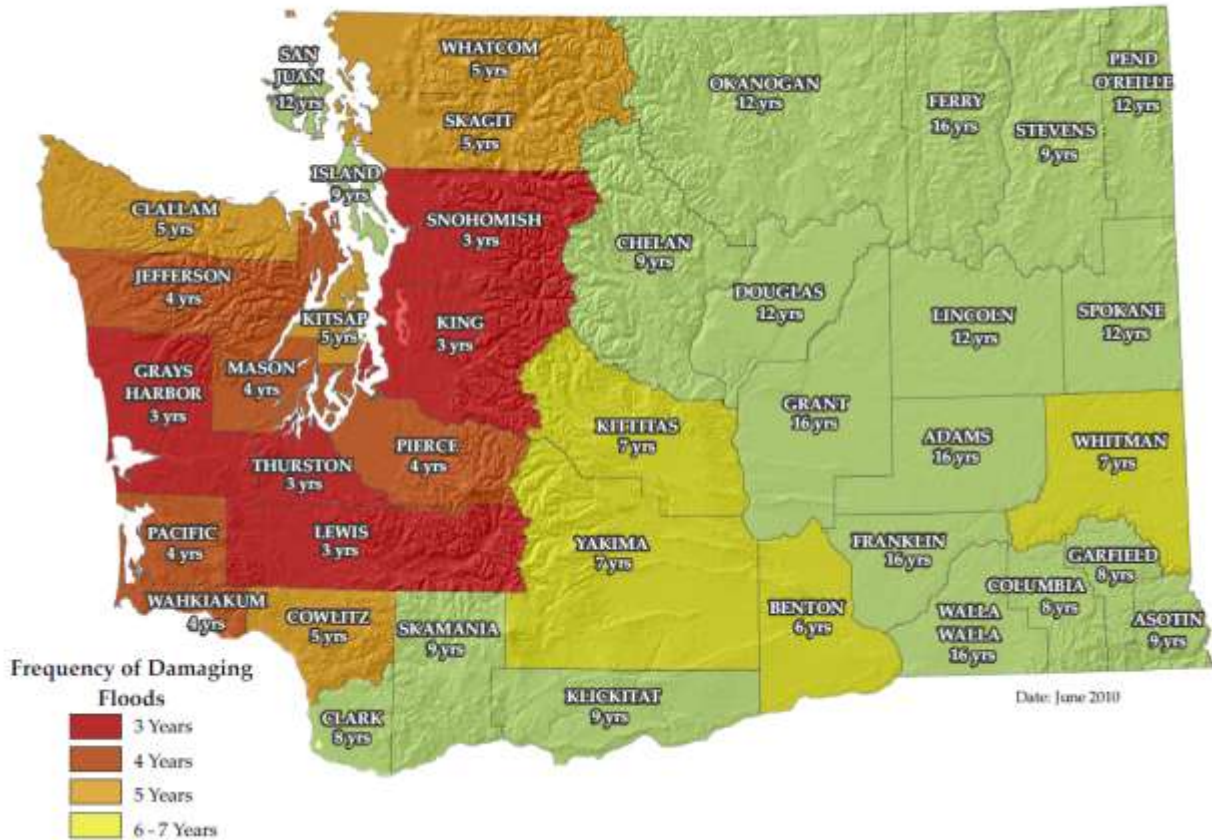
Clark	Cowlitz	Grays Harbor	King	Wahkiakum
Lewis	Mason	Pacific	Pierce	Kittitas
Skagit	Snohomish	Thurston	Whatcom	

Counties at Risk and Vulnerable to Floods



Hazard Profile – Flood

Frequency of Flooding Causing Major Damage, 1956 - Present



Frequency of Major Flood Occurrence

Frequency of Flooding Causing Major Damage, Since 1956 through 2009

Grays Harbor	3	Clallam	5
King	3	Cowlitz	5
Lewis	3	Kitsap	5
Snohomish	3	Skagit	5
Thurston	3	Whatcom	5
Jefferson	4	Benton	6
Mason	4	Kittitas	7
Pacific	4	Whitman	7
Pierce	4	Yakima	7
Wahkiakum	4		

Presidential Disaster Declarations provide a good indicator of major damage caused by a hazard event. There have been 33 Presidential Disaster Declarations for flooding since 1956. Each county has received at least three disaster declarations for flooding since 1956.³³

The counties in the table to the left are those that have experienced the most frequent flooding resulting in major damages and a Presidential Disaster Declaration during the time period 1956.

Occurrence rates are approximate, and rounded to the nearest year.

Hazard Profile – Flood

For the 2010 analysis, it was determined that twenty-two (22) counties have two (2) percent or more of their area in floodplain.³⁴ The analysis conducted to determine percentage in floodplain has a greater level of accuracy for this plan edition as analysis was conducted on only land mass, where before the analysis was conducted by county boundary. For example, Kitsap County's boundary travels into the Puget Sound. During this year's analysis, only land areas were utilized when analysis was conducted, and not the county boundary. This, for some counties, dramatically reduced their percentage of area in the floodplain.

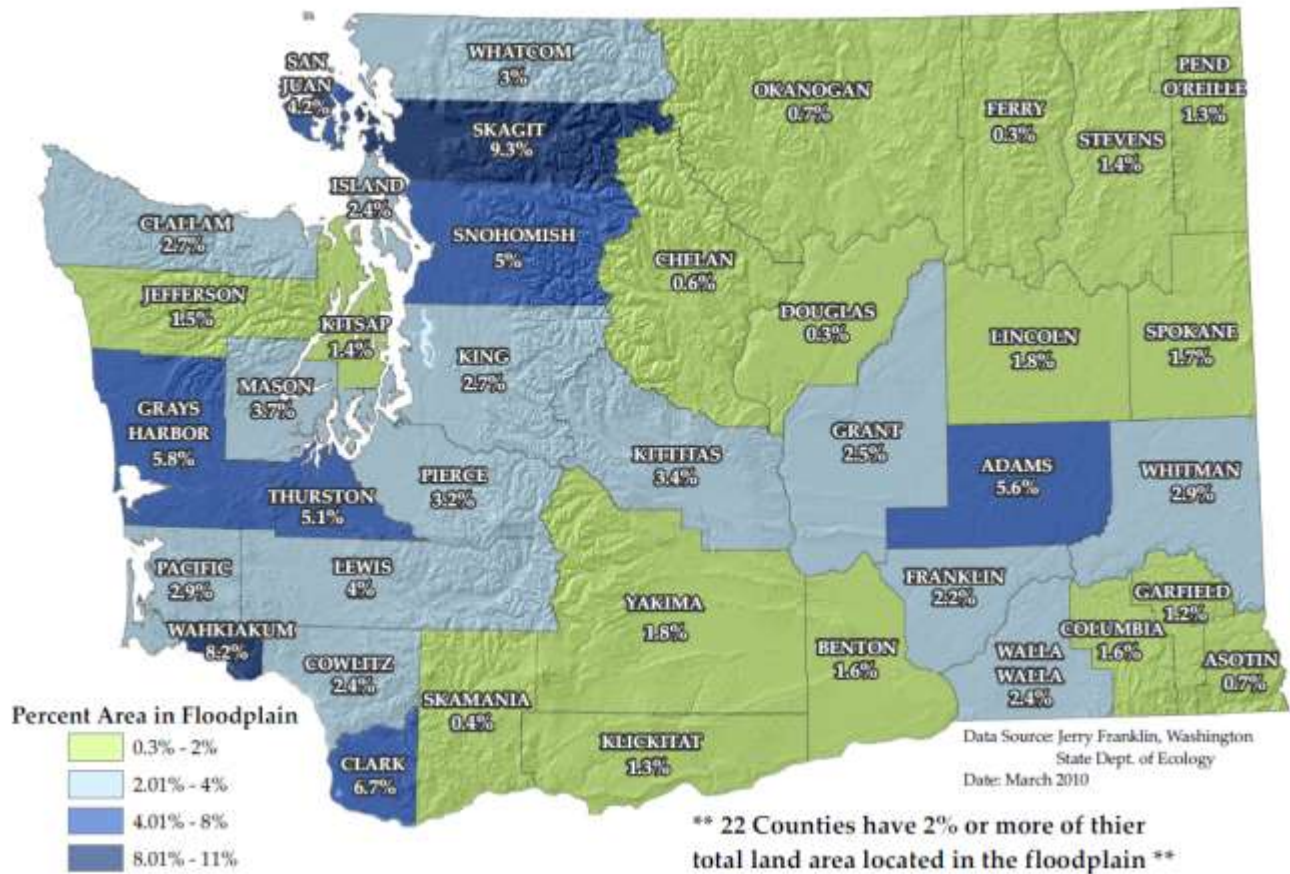
Hazard Profile – Flood

Percentage of County in Floodplain as of January 2010

COUNTY	Total County Land Area square miles	Total Floodplain square miles	Percent Floodplain
Adams	1925	108.6	5.6%
Asotin	636	4.3	0.7%
Benton	1703	27.7	1.6%
Chelan	2922	17.5	0.6%
Clallam	1745	47.6	2.7%
Clark	628	42.2	6.7%
Columbia	869	14.0	1.6%
Cowlitz	1139	27.4	2.4%
Douglas	1821	5.7	0.3%
Ferry	2204	6.3	0.3%
Franklin	1242	27.4	2.2%
Garfield	711	8.3	1.2%
Grant	2676	67.0	2.5%
Grays Harbor	1917	112.1	5.8%
Island	209	4.9	2.4%
Jefferson	1809	27.9	1.5%
King	2126	58.4	2.7%
Kitsap	396	5.4	1.4%
Kittitas	2297	77.7	3.4%
Klickitat	1873	24.2	1.3%
Lewis	2408	97.3	4.0%
Lincoln	2311	40.7	1.8%
Mason	961	36.0	3.7%
Okanogan	5268	36.5	0.7%
Pacific	975	27.9	2.9%
Pend Oreille	1401	17.6	1.3%
Pierce	1676	53.3	3.2%
San Juan	175	7.4	4.2%
Skagit	1735	161.3	9.3%
Skamania	1657	5.9	0.4%
Snohomish	2090	104.3	5.0%
Spokane	1764	30.0	1.7%
Stevens	2478	33.5	1.4%
Thurston	727	36.8	5.1%
Wahkiakum	264	21.7	8.2%
Walla Walla	1271	30.0	2.4%
Whatcom	2120	63.6	3.0%
Whitman	2159	62.1	2.9%
Yakima	4296	76.9	1.8%

Hazard Profile – Flood

Percent of County Land Area Located in the Floodplain, 2010



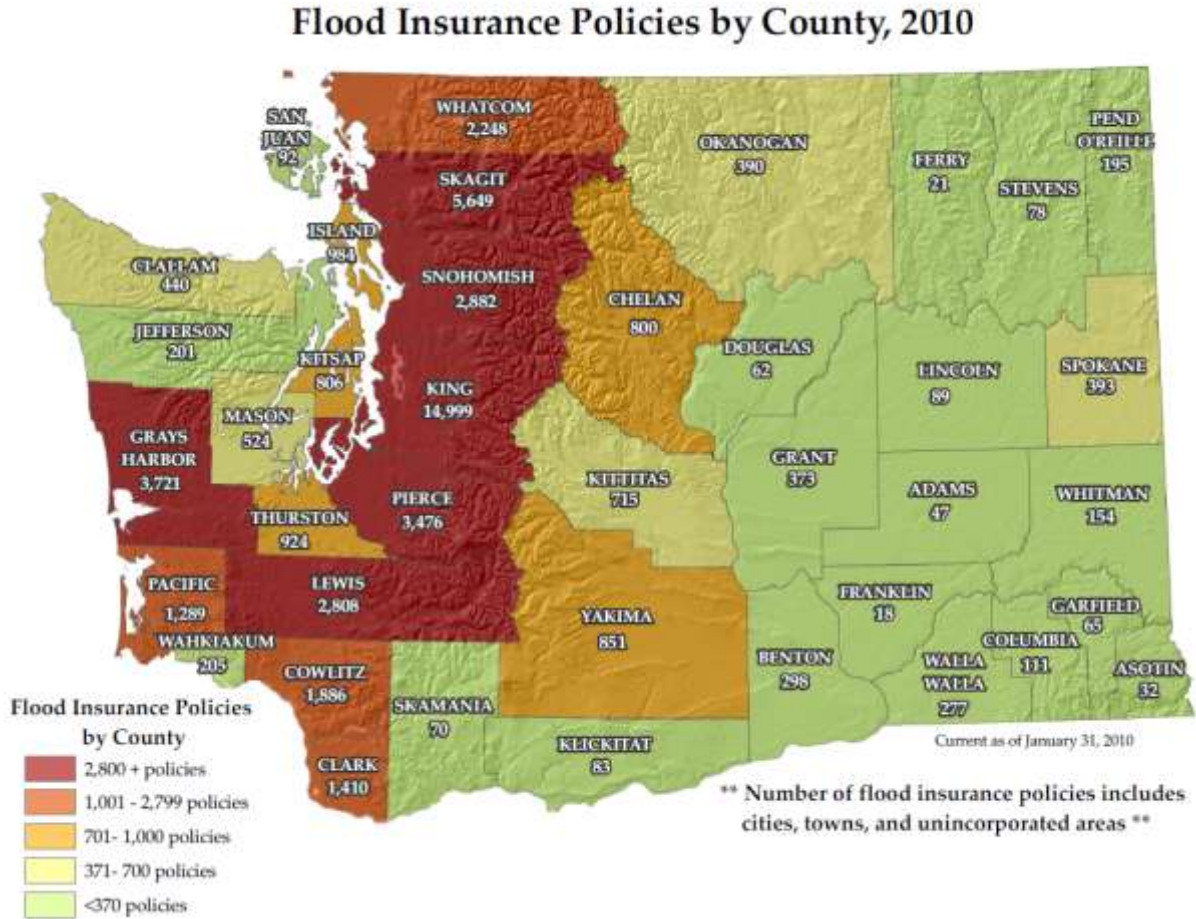
Hazard Profile – Flood

Percent of County Land Area Located in Floodplain as of January 2010

COUNTY	Total County Land Area sq_miles	Total Floodplain sq_miles	% Floodplain
Skagit	1735	161.3	9.3%
Wahkiakum	264	21.7	8.2%
Clark	628	42.2	6.7%
Grays Harbor	1917	112.1	5.8%
Adams	1925	108.6	5.6%
Thurston	727	36.8	5.1%
Snohomish	2090	104.3	5.0%
San Juan	175	7.4	4.2%
Lewis	2408	97.3	4.0%
Mason	961	36.0	3.7%
Kittitas	2297	77.7	3.4%
Pierce	1676	53.3	3.2%
Whatcom	2120	63.6	3.0%
Whitman	2159	62.1	2.9%
Pacific	975	27.9	2.9%
King	2126	58.4	2.7%
Clallam	1745	47.6	2.7%
Grant	2676	67.0	2.5%
Cowlitz	1139	27.4	2.4%
Walla Walla	1271	30.0	2.4%
Island	209	4.9	2.4%
Franklin	1242	27.4	2.2%

Hazard Profile – Flood

Flood Insurance Policies in Place



County	# Policies	County	# Policies
King	14,999	Island	984
Skagit	5,649	Thurston	924
Grays Harbor	3,721	Yakima	851
Pierce	3,476	Kitsap	806
Snohomish	2,882	Chelan	800
Lewis	2,808	Kittitas	715
Whatcom	2,248	Mason	524
Cowlitz	1,886	Clallam	440
Clark	1,410	Spokane	393
Pacific	1,289	Okanogan	390

As of January 31, 2010, twenty counties with the largest number of flood insurance policies currently in force; number includes their cities, towns and unincorporated area.³⁵

Hazard Profile – Flood

Flood Insurance Policies and Claims by County* Through January 31, 2010

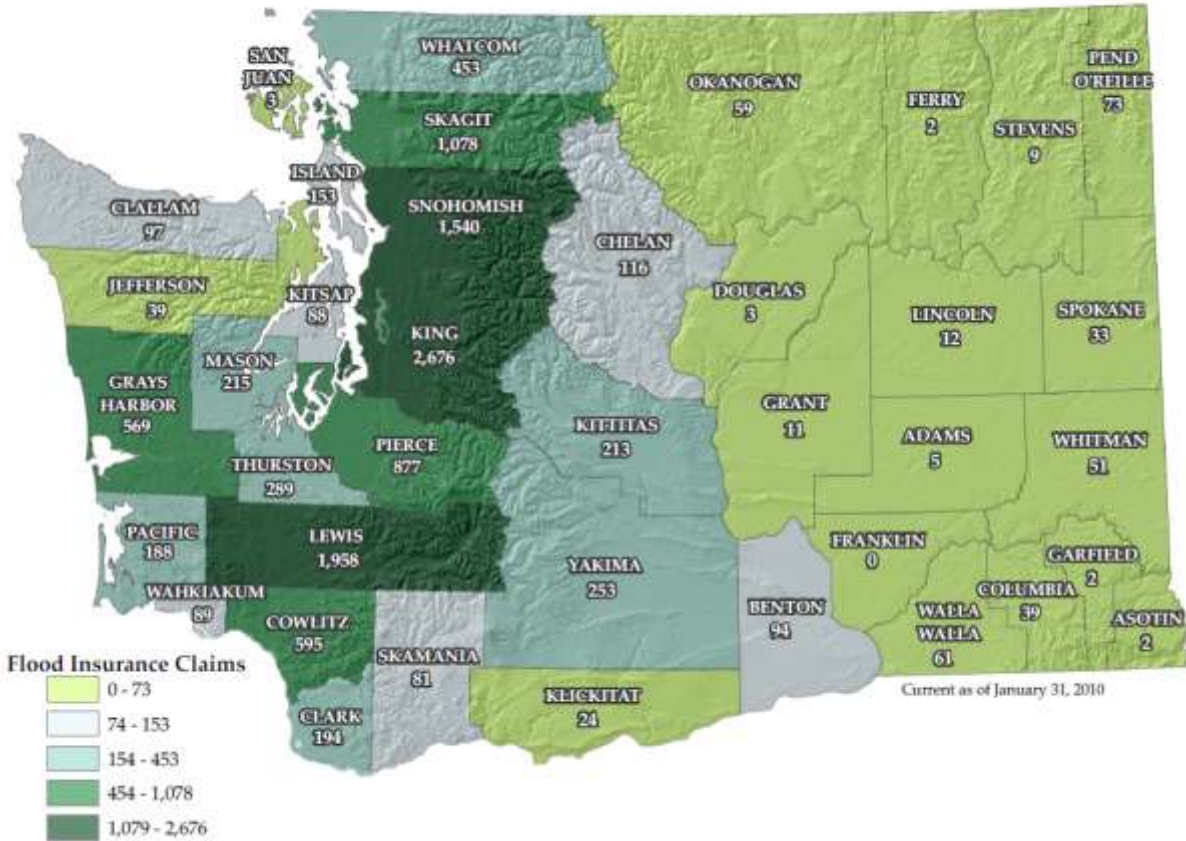
County	No. of Policies	No. of Claims Filed
King	14,999	2,676
Skagit	5,649	1,078
Grays Harbor	3,721	569
Pierce	3,476	877
Snohomish	2,882	1,540
Lewis	2,808	1,958
Whatcom	2,248	453
Cowlitz	1,886	595
Clark	1,410	194
Pacific	1,289	188
Island	984	153
Thurston	924	289
Yakima	851	253
Kitsap	806	88
Chelan	800	116
Kittitas	715	213
Mason	524	215
Clallam	440	97
Spokane	393	33
Okanogan	390	59
Grant	373	11
Benton	298	94
Walla Walla	277	61
Wahkiakum	205	89
Jefferson	201	39
Pend Oreille	195	73
Whitman	154	51
Columbia	111	39
San Juan	92	3
Lincoln	89	12
Klickitat	83	24
Stevens	78	9
Skamania	70	81
Garfield	65	2
Douglas	62	3
Adams	47	5
Asotin	32	2
Ferry	21	2
Franklin	18	0
TOTALS	49,314	12,174

* County total – includes incorporated cities and towns

Hazard Profile – Flood

Flood Insurance Claims

Flood Insurance Claims by County, 1978 - Present



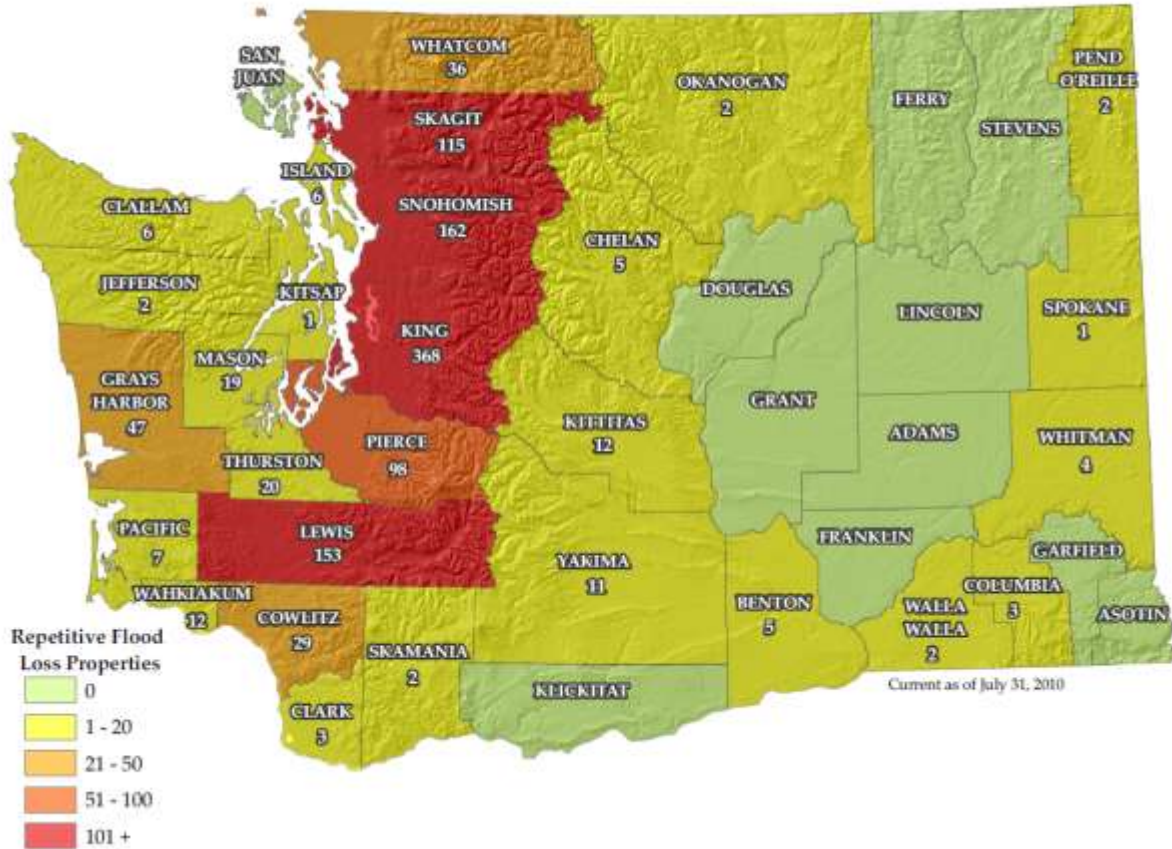
County	# Claims	County	# Claims
King	2,676	Mason	215
Lewis	1,958	Kittitas	213
Snohomish	1,540	Clark	194
Skagit	1,078	Pacific	188
Pierce	877	Island	153
Cowlitz	595	Chelan	116
Grays Harbor	569	Clallam	97
Whatcom	453	Benton	94
Thurston	289	Wahkiakum	89
Yakima	253	Kitsap	88

Top 20 counties with most flood insurance claims; number includes their cities, towns and unincorporated area.³⁶ A complete list of all claim information filed is available at the end of this section as Appendix A.

Hazard Profile – Flood

Repetitive Flood Loss (RFL) Properties³⁷

Counties with Repetitive Flood Loss Properties



County	# RFL Properties*	County	# RFL Properties*
King	368	Clallam	6
Snohomish	162	Island	6
Lewis	153	Benton	5
Skagit	115	Chelan	5
Pierce	98	Whitman	4
Grays Harbor	47	Clark	3
Whatcom	36	Columbia	3
Cowlitz	29	Skamania	2
Thurston	20	Jefferson	2
Mason	19	Okanogan	2
Kittitas	12	Pend Oreille	2
Wahkiakum	12	Walla Walla	2
Yakima	11	Spokane	1
Pacific	7	Kitsap	1

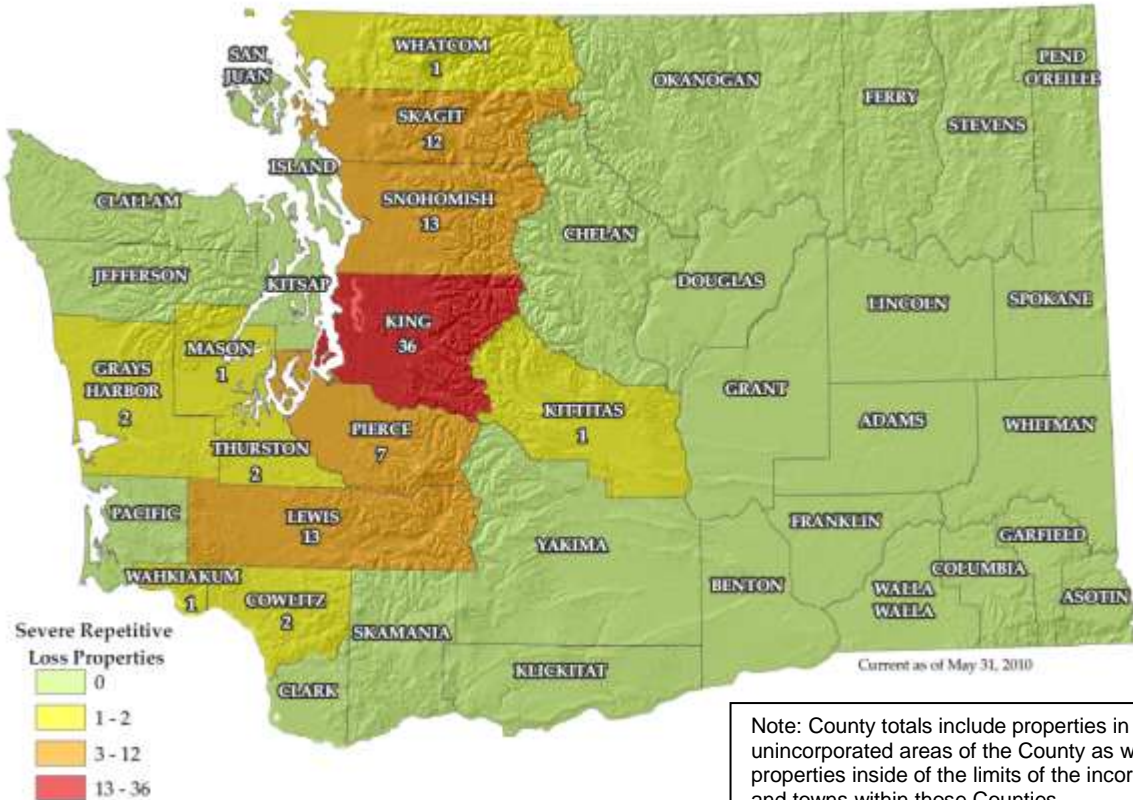
* Current as of July 31, 2009

Hazard Profile – Flood

Note: County totals include properties in the unincorporated areas of the County as well as the properties inside of the limits of the incorporated cities and towns within those Counties.

Severe Repetitive Flood Loss Properties³⁸

Counties with Severe Repetitive Flood Loss Properties



County	# Severe RFL Properties*
King	36
Snohomish	13
Lewis	13
Skagit	12
Pierce	7
Cowlitz	2
Grays Harbor	2
Thurston	2
Kittitas	1
Mason	1
Wahkiakum	1
Whatcom	1
Total	91

* Current as of May 31, 2009

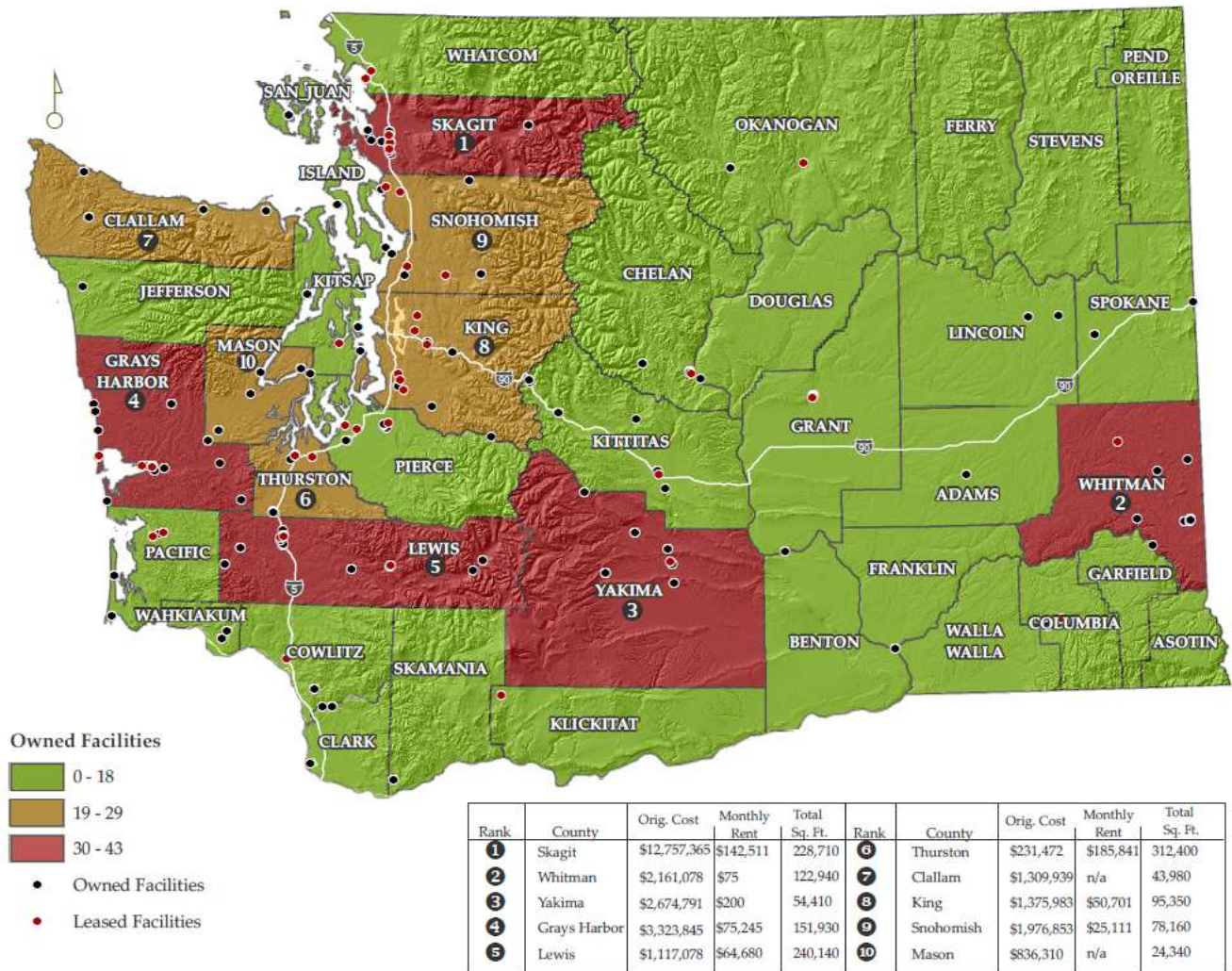
Hazard Profile – Flood

Jurisdictions Most Vulnerable to Flood							
County	Approx. Frequency of Occurrence	% Area in Flood Plain	# Flood Insurance Policies	# Flood Insurance Claims	# Repetitive Flood Loss Properties	# Severe Repetitive Loss	Score
Snohomish	3 Yrs.	5.0%	2882	1540	162	13	23
Lewis	3 Yrs.	4.0%	2808	1958	153	13	23
Skagit	5 Yrs.	9.3%	5649	1078	115	12	22
King	3 Yrs.	2.7%	14999	2676	368	36	21
Pierce	4 Yrs.	3.20%	3476	877	98	7	19
Grays Harbor	3 Yrs.	5.8%	3721	569	47	2	17
Whatcom	5 Yrs.	3.0%	2248	453	36	1	14
Thurston	3 Yrs.	5.1%	924	289	20	2	14
Cowlitz	5 Yrs.	2.4%	1886	595	29	2	12
Mason	4 Yrs.	3.7%	524	215	19	1	11
Clark	8 Yrs.	6.7%	1410	194	3	0	10
Wahkiakum	4 Yrs.	8.2%	205	89			10
Pacific	4 Yrs.	2.9%	1289	188	7	0	9
Kittitas	7 Yrs.	3.4%	715	213	12	1	9
Legend							
	3 Yrs.	6.5% or More	> 2,000	> 750	> 100	10 or more	4 pts each
	4 Yrs.	4.0 – 6.4%	1,000 – 1,999	300 – 749	50 - 99	7 - 9	3 pts each
	5 Yrs.	3.0 – 3.9%	500 – 999	100 – 299	20 - 49	4 - 6	2 pts each
	6 – 7 Yrs.	2.0 – 2.9%	250 – 499	50 – 99	1 - 19	1-3	1 pt each

Note: Counties identified on previous pages as being one of the top jurisdictions in one or more of the identified factors that received less than nine points are excluded from the table above.

Hazard Profile – Flood

State Owned & Leased Facilities at Risk to Flood



Hazard Profile – Flood

WHAT'S NEXT?

Flood Control Assistance Account Program (FCAAP)

During the next three year planning cycle update, Washington State Department of Ecology plans to continue to seek legislative authorization to secure additional funding for the Flood Control Assistance Account Program (FCAAP) to provide more and larger grants for flood hazard mitigation projects. For the 2009-11 biennium the Governor's recommended budget included an additional \$4 million for flood damage prevention grants. However, due to State revenue shortfalls this addition was lost along with 50% of the existing FCAAP allocation. Since the need for such funding has been well documented, as FCAAP grant funds requested generally exceed available funds by 400-600%, Ecology hopes to secure additional funding in future biennia.

FCAAP grants will continue to be coordinated with the State Emergency Management Division's (EMD) operation of their hazard mitigation grants to the extent possible. Staff from each agency will continue to participate in the grant application evaluation process for both FCAAP and the unified HMA grants.

Severe Repetitive Loss (SRL) Program

Ecology and EMD are in the process of developing a strategy to maximize the use of the Severe Repetitive Loss (SRL) Program grant funding. This effort will target the 91 SRLs in the state and will include the use of Increased Cost of Compliance (ICC) funds from the property owners' flood insurance policies. It will include training for local governments, outreach, and coordination with FEMA Region X staff.

Floodplain Management

Ecology will also continue efforts to enhance the State level rules for floodplain management. Recommendations for strengthening land use and construction standards in Special Flood Hazard Areas will be revisited and refined as indicated in coordination with other agencies and environmental and economic interest groups.

Risk MAP (Risk Mapping Assessment and Planning)

The purpose behind FEMA's Risk MAP Strategy is to constantly reduce losses to life and property. Flood mapping is used for risk assessments which are incorporated into mitigation plans where risk reduction measures are identified for future action. Risk MAP will identify, assess, and communicate multi-hazard risks with non-regulatory products and assessments. Washington State Department of Ecology is partnering with FEMA to implement the four fundamental strategies to Risk MAP in Washington State. The four strategies include Identify Risk, Assess Risk, Communicate Risk, and Mitigate Risk. The Risk MAP program further enhances mapping by involving communities during the assessment and planning stages, and guides and encourages communities to communicate risk to their constituents.

Hazard Profile – Flood

Appendix A³⁹ NFIP Loss Statistics by Washington State Jurisdictions 1978 through December 31, 2009

LOSS STATISTICS WASHINGTON AS OF 12/31/2009					
COMMUNITY NAME	TOTAL LOSSES	CLOSED LOSSES	OPEN LOSSES	CWOP LOSSES	TOTAL PAYMENTS
ABERDEEN, CITY OF	220	144	1	75	686,941.00
ALBION, TOWN OF	4	4	0	0	38,033.66
ALMIRA, TOWN OF	2	1	0	1	3,338.05
ARLINGTON, CITY OF	8	8	0	0	202,257.57
ASOTIN COUNTY*	2	2	0	0	11,260.72
AUBURN, CITY OF	8	6	0	2	43,341.02
BAINBRIDGE ISLAND, CITY	3	3	0	0	96,005.37
BATTLE GROUND, CITY OF	3	2	0	1	3,265.40
BELLEVUE, CITY OF	40	28	1	11	527,701.29
BELLINGHAM, CITY OF	25	18	0	7	655,542.36
BENTON CITY, TOWN OF	19	15	0	4	211,461.44
BENTON COUNTY *	36	30	0	6	592,557.52
BLAINE, CITY OF	2	2	0	0	22,115.36
BONNEY LAKE, CITY OF	2	2	0	0	8,753.69
BOTHELL, CITY OF	9	7	0	2	33,665.27
BREMERTON, CITY OF	6	5	0	1	8,905.60
BREWSTER, TOWN OF	1	1	0	0	4,700.29
BRIER, CITY OF	3	1	0	2	9,680.81
BUCKLEY, CITY OF	5	4	0	1	127,368.45
BUCODA, TOWN OF	43	38	0	5	257,010.48
BURIEN, CITY OF	12	7	0	5	76,180.28
BURLINGTON, CITY OF	30	16	0	14	45,650.94
CAMAS, CITY OF	4	3	0	1	13,710.27
CARNATION, CITY OF	26	20	1	5	771,646.68
CASHMERE, CITY OF	7	1	0	6	7,976.50
CASTLE ROCK, CITY OF	29	21	1	7	582,834.48
CATHLAMET, TOWN OF	1	1	0	0	4,906.03
CENTRALIA, CITY OF	717	662	7	48	25,202,553.92
CHEHALIS, CITY OF	508	442	7	59	27,881,498.57
CHELAN COUNTY *	98	74	0	24	975,185.13
CHENEY, CITY OF	1	0	0	1	.00
CHEWELAH, CITY OF	4	1	0	3	4,552.62
CLALLAM COUNTY *	82	46	0	36	944,108.31
CLARK COUNTY *	101	76	2	23	1,656,635.79
CLE ELUM, CITY OF	12	9	0	3	184,003.56
COLLEGE PLACE, CITY OF	1	1	0	0	4,259.05
COLUMBIA COUNTY*	2	1	0	1	7,903.48
CONCRETE, TOWN OF	15	12	0	3	93,078.44
COSMOPOLIS, CITY OF	3	3	0	0	2,021.76
COWLITZ COUNTY *	410	345	0	65	8,976,031.55
CUSICK, TOWN OF	2	2	0	0	1,000.00
DARRINGTON, TOWN OF	3	1	0	2	132,901.34
DAYTON, CITY OF	36	25	0	11	141,396.90
DES MOINES, CITY OF	4	4	0	0	211,934.98
DOUGLAS COUNTY *	3	3	0	0	20,029.18
DUVALL, CITY OF	4	4	0	0	141,107.89
EDMONDS, CITY OF	17	13	0	4	334,295.64
ELLENSBURG, CITY OF	24	17	0	7	193,670.64
ELMA, CITY OF	18	18	0	0	487,641.12
ENDICOTT, TOWN OF	1	1	0	0	1,432.85
ENUMCLAW, CITY OF	3	3	0	0	69,500.65
EPHRATA, CITY OF	9	2	0	7	9,100.42
EVERETT, CITY OF	12	8	0	4	219,839.71
EVERSON, CITY OF	46	38	0	8	426,052.24
FERNDALE, CITY OF	37	29	0	8	1,048,432.06
FERRY COUNTY *	2	1	0	1	11,770.96
FIFE, CITY OF	4	3	0	1	19,232.23
FIRCREST, CITY OF	12	8	0	4	79,427.69
FORKS, CITY OF	1	1	0	0	2,556.64
GARFIELD, TOWN OF	2	2	0	0	24,665.92
GIG HARBOR, TOWN OF	2	1	0	1	2,375.03
GOLD BAR, CITY OF	1	1	0	0	1,002.24
GOLDENDALE, CITY OF	1	1	0	0	4,595.36
GRANITE FALLS, CITY OF	1	0	0	1	.00
GRANT COUNTY*	1	1	0	0	2,423.42
GRAYS HARBOR COUNTY*	203	180	3	20	4,314,386.81
HAMILTON, TOWN OF	224	198	0	26	3,911,359.77
HOQUIAM, CITY OF	72	52	0	20	357,654.61
ILWACO, TOWN OF	4	2	0	2	4,595.09
INDEX, TOWN OF	34	28	0	6	477,053.48
ISLAND COUNTY *	151	104	1	46	1,145,212.44
ISSAQUAH, CITY OF	147	121	1	25	3,899,102.42
JEFFERSON COUNTY *	31	21	1	9	298,887.63

Hazard Profile – Flood

KALAMA, CITY OF	3	3	0	0	93,973.60
KELSO, CITY OF	45	34	0	11	629,341.93
KENMORE, CITY OF	1	1	0	0	14,697.30
KENNEWICK, CITY OF	4	2	0	2	7,288.30
KENT, CITY OF	28	11	0	17	123,550.15
KING COUNTY*	1,124	931	3	190	20,991,625.85
KIRKLAND, CITY OF	6	4	0	2	44,518.84
KITSAP COUNTY *	79	43	0	36	1,262,997.51
KITTITAS COUNTY *	168	141	0	27	1,880,173.59
KITTITAS, TOWN OF	8	3	0	5	5,558.19
KLICKITAT COUNTY *	23	21	0	2	305,085.56
LA CONNER, TOWN OF	5	2	0	3	2,664.54
LACEY, CITY OF	3	1	0	2	8,088.08
LAKE FOREST PARK, CITY	3	1	0	2	1,886.44
LAKE STEVENS, CITY OF	4	3	0	1	17,059.83
LANGLEY, CITY OF	2	0	0	2	.00
LEAVENWORTH, CITY OF	4	3	0	1	87,000.27
LEWIS COUNTY *	726	630	11	85	22,432,705.49
LIND, TOWN OF	1	1	0	0	18,431.39
LONG BEACH, TOWN OF	1	1	0	0	5,025.50
LONGVIEW, CITY OF	39	23	0	16	362,520.45
LUMMI INDIAN RESERVATIO	7	6	0	1	141,846.11
LYNDEN, CITY OF	4	4	0	0	16,134.99
LYNNWOOD, CITY OF	21	20	0	1	822,652.66
MARYSVILLE, CITY OF	7	4	0	3	18,332.92
MASON COUNTY*	206	170	4	32	3,514,632.12
MEDICAL LAKE, CITY OF	1	0	0	1	.00
MERCER ISLAND, CITY OF	5	1	0	4	6,952.20
METALINE, TOWN OF	1	1	0	0	1,907.32
MILTON, CITY OF	4	4	0	0	70,379.73
MONROE, CITY OF	65	60	0	5	784,316.21
MONTESANO, CITY OF	15	14	0	1	195,095.97
MORTON, CITY OF	1	0	0	1	.00
MOSES LAKE, CITY OF	1	1	0	0	1,776.84
MOUNT VERNON, CITY OF	93	61	0	32	588,262.98
MOUNTLAKE TERRACE, CITY	5	4	0	1	51,411.08
MUKILTEO, CITY OF	1	1	0	0	4,015.00
NACHES, CITY OF	4	2	0	2	27,324.86
NEWPORT, CITY OF	1	1	0	0	22,829.85
NOOKSACK, CITY OF	2	1	0	1	1,843.30
NORMANDY PARK, CITY OF	7	3	0	4	13,978.43
NORTH BEND, CITY OF	78	61	0	17	985,053.86
OAKVILLE, CITY OF	8	8	0	0	231,456.51
OCEAN SHORES, CITY OF	21	12	0	9	194,080.31
OKANOGAN COUNTY *	30	19	0	11	268,266.87
OKANOGAN, CITY OF	11	8	0	3	29,052.96
OLYMPIA, CITY OF	17	15	0	2	351,787.46
OMAK, CITY OF	5	5	0	0	65,180.53
OROVILLE, TOWN OF	9	6	0	3	12,179.27
ORTING, TOWN OF	32	22	0	10	345,247.27
PACIFIC COUNTY *	129	91	0	38	2,072,188.14
PACIFIC, CITY OF	23	23	0	0	434,550.54
PALOUSE, CITY OF	8	4	0	4	262,593.41
PATEROS, TOWN OF	1	0	0	1	.00
PE ELL, TOWN OF	1	1	0	0	37,770.81
PEND OREILLE COUNTY *	69	64	0	5	973,319.41
PIERCE COUNTY*	497	415	2	80	10,850,831.31
POMEROY, CITY OF	2	1	0	1	94.98
PORT ANGELES, CITY OF	10	5	1	4	78,283.49
PORT TOWNSEND, CITY OF	9	4	0	5	26,687.08
PULLMAN, CITY OF	28	22	0	6	136,666.04
PUYALLUP, CITY OF	88	68	0	20	2,729,246.43
RAYMOND, CITY OF	39	35	0	4	262,004.67
REDMOND, CITY OF	10	4	0	6	21,542.88
RENTON, CITY OF	15	9	0	6	79,803.22
RICHLAND, CITY OF	17	11	0	6	175,651.79
RITZVILLE, CITY OF	3	2	0	1	6,545.26
ROSALIA, TOWN OF	2	1	0	1	9,183.40
SAMMAMISH, CITY OF	1	1	0	0	1,518.80
SAN JUAN COUNTY*	3	2	0	1	26,407.09
SEATTLE, CITY OF	157	95	0	62	1,281,230.29
SEDRO- WOOLLEY, CITY OF	33	29	0	4	336,318.68
SELAH, CITY OF	43	41	0	2	689,603.72
SEQUIM, CITY OF	7	2	0	5	55,797.74
SHELTON, CITY OF	12	8	0	4	132,510.12
SHORELINE, CITY OF	1	1	0	0	4,021.74
SKAGIT COUNTY *	678	553	2	123	7,190,819.23
SKAMANIA COUNTY *	79	72	0	7	1,351,980.52
SKYKOMISH, TOWN OF	17	17	0	0	302,290.82
SNOHOMISH COUNTY *	1,091	906	5	180	17,198,332.36
SNOHOMISH, CITY OF	54	47	0	7	1,039,286.32

Hazard Profile – Flood

SNOQUALMIE, CITY OF	947	864	2	81	17,730,818.75
SOUTH BEND, CITY OF	15	10	0	5	51,476.53
SOUTH CLE ELUM, CITY OF	1	1	0	0	8,374.12
SOUTH PRAIRIE, TOWN OF	18	14	1	3	198,616.37
SPANGLE, CITY OF	3	3	0	0	160,747.32
SPOKANE COUNTY*	17	10	0	7	187,712.84
SPOKANE, CITY OF	11	8	0	3	111,644.21
SPRAGUE, CITY OF	8	6	0	2	95,694.71
STANWOOD, CITY OF	33	23	0	10	412,078.64
STARBUCK, CITY OF	1	0	0	1	.00
STEILACOOM, TOWN OF	2	2	0	0	12,279.65
STEVENS COUNTY *	5	4	0	1	45,526.41
STEVENSON, TOWN OF	2	2	0	0	19,363.38
SULTAN, CITY OF	182	162	0	20	2,617,572.12
SUMAS, CITY OF	66	53	0	13	757,631.16
SUMNER, CITY OF	131	113	0	18	3,573,481.25
SUNNYSIDE, CITY OF	1	0	0	1	.00
TACOMA, CITY OF	77	58	0	19	1,337,885.36
TENINO, CITY OF	7	7	0	0	105,231.94
THURSTON COUNTY *	216	172	2	42	3,448,798.39
TOLEDO, CITY OF	4	3	0	1	75,538.10
TONASKET, TOWN OF	1	0	0	1	.00
TOPPENISH, CITY OF	8	7	0	1	43,550.02
TUKWILA, CITY OF	2	1	0	1	1,309.89
TUMWATER, CITY OF	2	2	0	0	12,514.40
UNION GAP, CITY OF	1	1	0	0	3,290.80
VANCOUVER, CITY OF	9	4	0	5	101,610.40
WAHKIAKUM COUNTY *	88	73	1	14	1,664,761.14
WAITSBURG, CITY OF	31	25	0	6	394,036.41
WALLA WALLA COUNTY *	29	21	0	8	315,907.64
WAPATO, CITY OF	8	7	0	1	30,433.06
WASHOUGAL, CITY OF	10	8	0	2	71,369.59
WASHTUCNA, TOWN OF	1	1	0	0	2,241.04
WENATCHEE, CITY OF	7	0	0	7	.00
WEST RICHLAND, TOWN OF	8	7	0	1	193,160.93
WESTPORT, CITY OF	11	7	0	4	96,860.90
WHATCOM COUNTY *	266	211	0	55	3,435,313.90
WHITMAN COUNTY *	6	3	0	3	1,956.71
WILBUR, TOWN OF	2	1	0	1	2,477.83
WILKESON, TOWN OF	3	3	0	0	36,351.45
WINLOCK, TOWN OF	2	1	0	1	859.31
WINTHROP, TOWN OF	1	0	0	1	.00
WOODLAND, CITY OF	69	51	0	18	988,025.89
YAKIMA COUNTY *	179	128	0	51	930,481.99
YAKIMA, CITY OF	9	5	0	4	14,963.69
YELM, CITY OF	2	1	0	1	7,602.70
TOTAL FOR WASHINGTON	12,184	9,945	60	2,179	233,100,101.72

Source: FEMA Claim Information by State, 1978 to 2009. Available at:
<http://bsa.nfipstat.com/reports/1040.htm>[4/1/2010 12:47:14 PM]

Hazard Profile – Flood

Glossary of Flood Terms

100-year flood: The flood having a 1% or greater annual probability of occurring.

500-year flood: The flood having a 0.2% or greater annual probability of occurring.

Base Flood: A flood having a 1-percent probability of being equaled or exceeded in any given year; also referred to as the 100-year flood.

Base Flood Elevation (BFE): Defined by FEMA as the elevation of the crest of the base or 100-year flood relative to mean sea level. BFE is not depth of flooding. To determine depth of flooding, you would need to subtract the lowest elevation of a particular property from the BFE.

Flood Insurance Rate Map (FIRM): An official map of a community, on which the Federal Insurance and Mitigation Administration has delineated both the Special Flood hazard Area's and the risk premium zones applicable to the community. Most FIRM's include detailed floodplain mapping for some or all of a community's floodplains.

Floodplain: Any land area susceptible to being inundated by floodwaters from any source.

Freeboard: A margin of safety added to the base flood elevation to account for waves, debris, miscalculations, or lack of data.

Panel: Panel number is numerical designation used to identify the FIRM Map associated with a given area. The first six digits of the Panel number is the community number.

Panel Date: This is the date recorded in the FEMA FMSIS database, which is associated with the given Panel Number.

Repetitive Loss Property: A property for which two or more National Flood Insurance Program losses of at least \$1,000 each have been paid within any 10 year period since 1978.

Special Flood Hazard Area (SFHA): An area designated as within a "Special Flood Hazard Area" (or SFHA) on a FIRM. This is an area inundated by 1% annual chance flooding for which BFEs or velocity may have been determined. No distinctions are made between the different flood hazard zones that may be included within the SFHA. These may include Zones A, AE, AO, AH, A99, AR, V, or VE.

Hazard Profile – Flood

¹ The totals come from the following sources: Stafford Act disaster assistance costs for disaster from 1980 through January 2009 come from a spreadsheet maintained by State Hazard Mitigation Officer for assistance programs managed by Washington Military Department, Emergency Management Division, (March 2009). Small Business Administration loan figures come from a spreadsheet covering disaster assistance loans provided by the U.S. Small Business Administration from 1992 through 2002, (April 28, 2003). Figures for Federal Highway Administration Emergency Relief Program assistance provided from 1980 to 2003 come from data supplied by the Washington State Department of Transportation, (March 2003). The totals do not include other disaster assistance, such as that provided by the U.S. Army Corps of Engineers to repair damages levees.

² David Kresch and Karen Dinicola, U.S. Department of the Interior, U.S. Geological Survey, Fact Sheet 228-96, *What Causes Floods in Washington State?*, date unknown.

³ Ibid.

⁴ FEMA. (2002) *NATIONAL FLOOD INSURANCE PROGRAM: PROGRAM DESCRIPTION*. Accessed: 1 April 2010. Available at: <http://www.fema.gov/library/viewRecord.do?id=1480>

⁵ FEMA Community Rating System. Accessed: 2 April 2010. Available at: <http://www.fema.gov/business/nfip/crs.shtm>

⁶ FEMA Map Modernization. Accessed: 2 April 2010. Available at: http://www.fema.gov/plan/prevent/fhm/mm_main.shtm

⁷ FEMA's Risk MAP (Mapping, Assessment, and Planning) Strategy. Accessed: 2 April 2010. Available at: <http://www.fema.gov/plan/ffmm.shtm>

⁸ MGS Engineering Consultants. *Map of 24-hour precipitation totals that would qualify as a 100-year event*. January 12, 2009. Accessed March 23, 2009. Available at: http://www.mgsengr.com/precipfrqfiles/wa_100y_24h_0120.png

⁹ Chris Hill et al., *Top Ten 20th Century Weather Events In Washington State*, National Weather Service, Seattle Forecast Office, December 1999, <<http://www.seawfo.noaa.gov/WATOP10.htm>>, (February 20, 2003).

¹⁰ Richard W. Paulson et al., *National Water Summary 1988-89, Hydrologic Events and Floods and Droughts*, Washington Floods and Droughts State Summary, United States Geological Survey Water-Supply Paper 2375, 1991.

¹¹ Sweeney, Michael. (4 Dec. 1977). "Officials Tally Flood Bill." *Seattle Times*. A-1, A-4.

¹² Information from *Flood Mitigation Implementation Measures Report for Whatcom County*, FEMA-676-DR, Washington State Department of Emergency Services et al., November 1983.

¹³ Information from *Flood Mitigation Strategies for Disasters 757 and 762, 1986*, Washington State Department of Community Development, Emergency Management Division, December 1, 1986.

¹⁴ Ibid.

¹⁵ Information from *Interagency Flood Hazard Mitigation Report*, FEMA-784-DR-WA, Region X Interagency Mitigation Team, January 1987.

¹⁶ Information from *Hazard Mitigation Survey Report*, FEMA-822-DR-WA, Washington State Department of Community Development, Division of Emergency Management, 1989.

¹⁷ Information from *Hazard Mitigation Opportunities in the State of Washington, Report of the Interagency Hazard Mitigation Team*, FEMA-852-DR-WA, Region X Interagency Hazard Mitigation Team, February 15, 1990.

Hazard Profile – Flood

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- ¹⁸ Chris Hill et al., *Top Ten 20th Century Weather Events In Washington State*, National Weather Service, Seattle Forecast Office, December 1999, <<http://www.seawfo.noaa.gov/WATOP10.htm>>, (February 20, 2003)
- ¹⁹ *Hazard Mitigation Opportunities in the State of Washington, Report of the Interagency Hazard Mitigation Team, FEMA-883-DR-WA*, Federal Emergency Management Agency Region X, January 1991.
- ²⁰ Information from *Interagency Hazard Mitigation Team Report, with Early Implementation Strategies for DR-1079-WA and DR-1100-WA*, Federal Emergency Management Agency Region X, July 1996.
- ²¹ Information from *Maximum stages and discharges during floods of November 28-30, 1995*, United States Geological Survey, Tacoma Office, January 1996.
- ²² Information from *Interagency Hazard Mitigation Team Report, with Early Implementation Strategies for DR-1079-WA and DR-1100-WA*, Federal Emergency Management Agency Region X, July 1996.
- ²³ Chris Hill et al., *Top Ten 20th Century Weather Events In Washington State*, National Weather Service, Seattle Forecast Office, December 1999, <<http://www.seawfo.noaa.gov/WATOP10.htm>>, (February 20, 2003).
- ²⁴ Information from *Post Event Report: Winter Storm of 1996-97, Federal Disaster DR 1159, Western Washington Summary*, US Army Corps of Engineers, Seattle District, Mary 16, 1997.
- ²⁵ Information from *Hazard Mitigation Survey Team Report for the 1996-1997 Washington Winter Storms, DR-1152-WA, DR-1159-WA, DR-1172-WA*, Washington State Emergency Management Division and Federal Emergency Management Agency Region 10.
- ²⁶ Information from *Post Event Report: Winter Storm of 1996-97, Federal Disaster DR 1159, Western Washington Summary*, US Army Corps of Engineers, Seattle District, Mary 16, 1997.
- ²⁷ Rick van der Zweep, *Washington State October 2003 Flood Report*, National Oceanic and Atmospheric Administration, Northwest River Forecast Center, <http://www.mwrfc.boaa.gov/floods/oct_2003/wa_oct2003_flood.html>, (March 26, 2004).
- ²⁸ Office of Washington State Climatologist. (2007). *Washington 2006 Top 10 Weather & Climate Events*. Accessed: March 23, 2009. Available at: <http://www.climate.washington.edu/events>
- ²⁹ Office of Washington State Climatologist. *2006 Record November Rainfall*. December 5, 2006. Accessed March 23, 2009. Available at: <http://www.climate.washington.edu/events/2006NovRain.html>
- ³⁰ Office of Washington State Climatologist. *December 2007 Record Flooding*. December 12, 2007. Accessed: March 23, 2009. Available at: <http://www.climate.washington.edu/events/dec2007floods>
- ³¹ FEMA. *Washington Disaster Aid Tops \$72.5 Million*. (2008). Accessed March 23, 2009. Available at: <http://www.fema.gov/news/newsrelease.fema?id=42969>
- ³² FEMA. *Almost \$11 Million in Disaster Assistance to Washington Residents with March 31st Deadline Fast Approaching*. March 20, 2009. Accessed March 23, 2009. Available at: <http://www.fema.gov/news/newsrelease.fema?id=47770>
- ³³ State Emergency Management Division records.
- ³⁴ Communication from Jerry Franklin, Washington State Department of Ecology, Floodplain Management Program, April 10, 2009.
- ³⁵ *National Flood Insurance Report. Generated by: Chuck Steele*, Washington State Department of Ecology. 25 March 25, 2010.
- ³⁶ Ibid.

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³⁷ Information from *National Flood Insurance Program NextGen SQANet*, Repetitive Flood Loss Report, <<http://www.nfipnextgen.com/awareness.html>>, (July 31, 2009).

³⁸ Information from *National Flood Insurance Program NextGen SQANet*, Severe Repetitive Flood Loss Report, <<http://www.nfipnextgen.com/awareness.html>>, (July 31, 2009).

³⁹ FEMA. NFIP Claim Information by State (1978 through 12/31/09). *Loss Statistics*. Accessed: 1 April 1, 2010. Available at: <http://www.fema.gov/business/nfip/statistics/pcstat.shtm>